This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

TRANSPORTATION
LIBRARY
TJ
605.5
.W36

A 749,372

AJAX LOQUITUR

THE AUTOBIOGRAPHY
OF AN OLD LOCOMOTIVE ENGINE

1817
ARTES VERITAS SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE

TRANSPORTATION
LIBRARY

Transportati
Library
TJ
605.5
.W36

AJAX LOQUITUR

GEORGE STEPHENSON.

"Brow, nose, lips, and jaw, bespoke the man" (*page* 20).

[*Frontispiece.*

AJAX LOQUITUR

THE [illegible]PHY OF AN OLD
[illegible] ENGINE

[illegible] AND SON
[illegible] HILL, E.C.

[illegible]

[illegible] man" [illegible]

AJAX LOQUITUR

OR

THE AUTOBIOGRAPHY OF AN OLD LOCOMOTIVE ENGINE

BY

ROBERT WEATHERBURN
M.I.M.E.

Capio Lumen

[illegible] ITY OF [illegible] GAN

LONDON
CROSBY LOCKWOOD AND SON
7 STATIONERS' HALL COURT, LUDGATE HILL, E.C.
1899

PRINTED BY
HAZELL, WATSON, AND VINEY, LD.,
LONDON AND AYLESBURY.

Transf. lib.

I.R.P. 3-14-46

CONTENTS

PAGE
AUTHOR'S NOTE 7
PROLOGUE 9

AJAX LOQUITUR:—

His Ancestors and Family History . . 13
Cylinders 23
Motions 40
Connecting Rods 52
Frames 58
Wheels 62
Pumps, Clacks, etc. 67
Injectors 69
Boilers 73
Smoke-Box 89
Chimney 93
Weather-Board and Awning. 99
Internal Dissensions 101
Engine-Drivers 131
EPILOGUE 147

ILLUSTRATIONS

PAGE

George Stephenson . . . . *Frontispiece*

"Ajax, otherwise Known as Old No. 9" . . 14

Robert Stephenson . . . . *facing page* 22

Cylinders 32

Link and Gabs 42

Dodds's Motion 45

Allen's Motion 46

Connecting Rods 54

Gorgon 70

Ulysses 72

Exhaust Pipe 90

Pistons 102

A Revolutionist 112

Crank-Pins 119

Blast-Pipe 121

IT would be pretentious with so small and unassuming a book to give a Preface. Besides, Prefaces have always appeared to me to have been written to fulfil one or more of three purposes, viz.:—

(1) To give the Author's reason or reasons for writing;

(2) To furnish some explanation or excuse as to the method, preparation, or quantity of his writings;

(3) To serve by way of introduction, too often of an apologetic nature.

Well, dealing with the first, I candidly avow that I sought to kill time during a short period of convalescence following a sharp and painful illness; secondly, I do not know that any explanation or excuse is required for having done so; thirdly, as regards an introduction, "Ajax" does not require any, but will, without apology, introduce himself in lieu of a Preface, and with the hope that none of his readers will be the worse for the reading of his history.

R. W.

PROLOGUE

DOUBTS may be cast upon the authenticity of this communication. If so, the fault will not be mine that I have become the recipient (so to speak) of the antecedents, life-history, and testamentary dispositions of Old No. 9, and thus, perforce, its biographer.

It may be that I always had a lingering and reverential regard for the old engine—a connecting link with the past—itself a rare combination of excellences gathered from diverse sources of thought and successful practice, and skilfully blended. Thus it was that, as I was passing one day, the old engine—which always won from me at least a momentary regard—looked so eloquent of past activity and work, and so lightened up by the burst of sunlight which peered and glinted over the gable ends of the workshop, as to appear like the features of a weather-beaten veteran, bronzed and wrinkled, and yet very interesting. So I stayed me; and the reflection born of the moment found utterance in words, and I muttered audibly, "Old boy, if you could only speak!"

For a moment I was more than surprised; for if fancy had not played me a trick, surely that dissipated-looking and rusty old chimney vibrated, the wheels made a palpable slip round, and what sounded at first very inarticulate, more like the spasmodic gasps of escaping steam, with a jingling of rods, at last led to intelligible utterance as follows:

"Speak? Most certainly. Why should I be longer mute? Neuter gender? Nonsense, my friend: they all speak, some through one medium, and some another. Why, all Nature speaks. Even the flowers, trees, and brutes, have all told their secrets through those cheerful listeners and sympathetic interpreters Hans Andersen and the old moralist Æsop. The half-obliterated records of the earlier Pharaohs on the temples and Pyramids talk daily; and old Memnon the mysterious speaks audibly at times, only his priestly interpreters are no longer there. Hence the total absence of all records. . . . You appear astounded, doubtful and hesitating; yet, as I may not have another opportunity, being under sentence to be broken up, take down my life's history, which at all events merits the title of a useful one."

Thus abjured, though startled, I took down, as nearly as possible in its own words, the following utterances of the old engine.

AJAX LOQUITUR

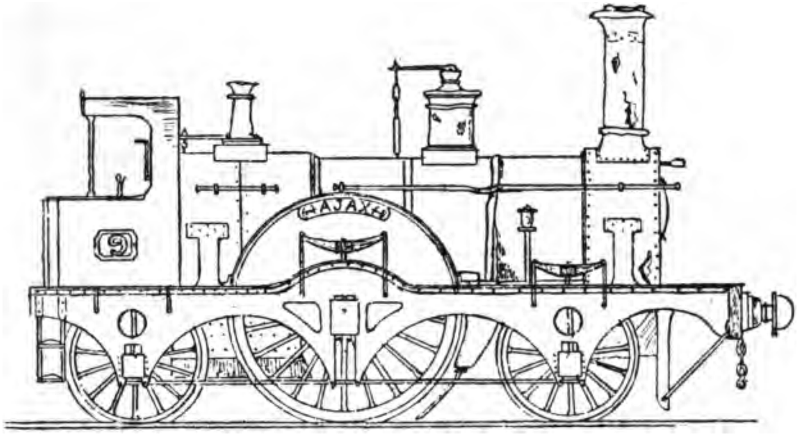
I, Ajax, whether Telamon or Teucer matters not, otherwise known as Old No. 9, feeling the burden of years, have no compunction—now that I am doomed to the scrap-heap—to indulge in the same vanity as many of my human congeners, and herewith give the principal facts concerning my career and experience, with a few prefatory notes as to my family history. . . .

I am the child of invention and experiment, the epitomised embodiment of centuries of thought.

I was ushered into the world by a legion of mechanics and philosophers.

My genealogy can be traced to very respectable pagan parentage.

Long before the advent of the second Prometheus, a singularly talented Greco-Egyptian, Hero, revealed a secret long hidden by the



"Ajax, otherwise known as Old No. 9" (*page* 13).

Egyptians, and demonstrated the power of steam by the strange gyrations he made one of my ancestors, Æolophile by name, to perform. More than a century before that, Archimedes of Syracuse fashioned and wrought out contributory agencies which constitute to this day the principles of mechanical science. After that, I sorrowfully confess that our genealogical record is not quite as clear as I would like; but in the sixteenth century, one of my forefathers, under difficulties of no ordinary kind, owing to the enmity of the priesthood, was made by Somerset, Marquis of Worcester, to go through movements of such a strange and weird character as to provoke the vilest slander and calumny, and at last was interdicted by Mother Church, a power superior to steam at that time.

I confess to another relapse until—centuries after—Cugnot, a military engineer in France, yoked one of my ancestors to a cannon, and paced him by catch and rack-and-pinion before the Great Emperor, who, square-headed as he was, knew more of gunpowder than steam, and failed to see its utility.

From this period I have no difficulty with my lineage. Watts and Newcomen demonstrated the power of vaporised water, and showed the value of reciprocative action ; and then another ancestor, named Catch-me-who-can, was made a raree-show of by one Trevethick, on a circular track at Bunhill-fields, at a-shilling-a-head admission. The family was now getting known, and several off-shoots appeared in South Wales, of which I have no reliable record ; but I can vouch for the fact that in the North of England strange things were done at Wylam, in Northumberland, by one of our family in hauling coal-waggons, under the tuition of Hedley.

But I now come to the time when our family fortunately received attention and study at the hands of the great Stephenson, who, recognising our claims, nursed us through the sickly and doubtful stage to a vigorous and useful manhood, and was not content until he had proved our adaptability to all purposes of haulage and transport. Indeed, his faith and reliance in us were such that he did not hesitate to predict that we should revolutionise the country, a prophecy that he lived to see fulfilled. From that time our family were recognised in the land as necessary to the State and Commonwealth. At that period, however, although useful, we were not so well proportioned and good-looking; but our progress was marked by rapid evolution and development.

Now, for myself, I matured in Lancashire, under the able direction of one of the best men of the day, who was so pleased with me that he labelled me with his own name, after the fashion of the old Saxons with their serfs. I carried it many a year, until—frames, motion, and wheels excepted—there was hardly a piece of my original self left.

I feel that I appear at a disadvantage when compared with that gigantic engine close alongside at this moment, which haughtily looks down upon me; but this is only what I deserve. With shame I remember entertaining the same feelings towards others which had preceded me; but I honestly assure you that these giants owe more to their size, pressure, and weight, than to any other particularly noteworthy feature. I feel pained that I suffer by the contrast. Years of hard work from fast-train running, until I was put to the ignoble use of occasional ballasting, have left their mark, but have not broken my spirit.

When first turned out of the factory, over fifty years ago, in the glory of new paint and polished rods, I became the centre of a group of human admirers. Family pride has ever been our bane, and I recognise in my descendants the same unfortunate failing. In another fifty years their punishment will come; and the big-wheeled leviathan who now so scornfully races by me, without one sign of recognition, may then be found, rusty and dust-covered, standing in a corner, awaiting the hammer and the shears.

I must tell you that at the time I was under hand the laws which govern the action of steam were only imperfectly understood. Indeed, our family, from the first, although dependent on the same laws, declined to submit to the favourite practice of Watts and Newcomen, and never descended below the atmospheric line to obtain power or energy. My designers, like those of the present day, aimed at originality, but, like wise men, were not too proud to adopt whatever appeared to be good and successful features of locomotive practice.

I had, as you will observe, inside cylinders, with brass piston-heads and valves, as well as Stephenson's link motion, of which I was inordinately proud, as many of my contemporaries still kept to the fork and gab. My crank axles were made of the best iron, left crank leading, the arms placed at an angle of ninety degrees. The other axles were also of equal quality of iron. The wheels, but not the tyres, are the originals, as you see, and are still very good; they cost my manufacturers much good time and money. They were literally built up of a great number of parts, and constituted a masterpiece of smith's work. The frames, although appearing light, were strong, and hard work has proven their stability.

It may interest you to know that during my design and manufacture I was privileged to hear daily names which have now become famous — a few unjustly so. Others which should have been credited have been denied the originality which was undoubtedly theirs.

The Stephensons, father and son, Bury, Tayleur, Hackworth, Gray, Trevethick, Sharp, Roberts—every one of these, through their contributions, stood sponsor for me. Only once, however, in active life, was I privileged by seeing the great Stephenson.

Old engines, you see, like old men, are prone to be talkative; but I will narrate what once I heard, which is somewhat interesting, and which occurred when I drew up at the terminus station after finishing my trip one day. I had then, for the first time, the uneasy feeling of being under skilled critical observation, and had particularly noted a tall, portly man—whose personality was established by his massive limbs, shoulders, and head—approaching me. Curiously and intuitively, I felt myself in the presence of the Master. . . . Brow, nose, lips, and jaw bespoke the man. . . . The heavy beaver hat only partly covered the brow, and that in turn overshadowed the penetrating eyes, which slowly but intelligently swept over my profile and mechanism with a critical glance.

Gradually this regardful look toned down the asperities of his countenance, and a smile of pleasant approval followed, due, no doubt, to the recognition of the homage paid him by the many features which had been copied from his own work. . . . With the ferruled end of his slowly-lifted walking stick he poked me here and there, and at last, having rested it on one of the curved links of the valve motion, for the first time in my hearing, he spoke to a younger man who stood by, the possessor of one of the most refined and classic faces it had been my lot to behold. "Robert," said he, "hast thou noticed the link motion?" . . . There was a fulness of intonation in his voice, and a "burr" in his speech, which betrayed him as a descendant of the great Norse people, who had settled down north of the Humber at the bidding of their Saxon conqueror, and were predestined to more than repay to the country the kindness shown by their chivalrous and merciful victor. True son and descendant was he of the Vikings, big of limb and rough of speech.

But the younger man's face pleased me the most; there, was the blend of the vigour of the race with the repose which came from intellectual strength, developed by high scholarship and student habits. . . . With impatience I awaited the reply to the father from the son! "Yes," the latter slowly answered, "the motion appears well proportioned, and indeed, the whole engine is an improved Planet." Father and son, coadjutors in every sense, then walked slowly away, and I confess that I liked the son still better after hearing him speak.

So much for the inherent vanity of a locomotive.

ROBERT STEPHENSON.

"There, was the blend of the vigour of the race with the repose which came from intellectual strength, developed by high scholarship and student habits."

[*To face p.* 22.

CYLINDERS

AFTER so many years of hard work, it will be a surprise to you to know that the cylinders are the original ones; and this speaks eloquently for the quality of the iron from which they were cast. . . . I remember what a long and tedious discussion occurred as to its selection, and at last it was decided, on the advice of the chief moulder, that an old beam-pumping engine cylinder, which had done duty for some years, and was known to be of tough, close-grained iron, was selected. The utmost care was given in casting; and the sample headings, when broken, gave that grey, close, even grain which has now established itself as the recognised peculiarity of good quality to this day.

Experience at that time was too limited to secure proportion as accurately as for present-day engines, but the length of ports was as nearly as could be the same as the diameter of the cylinders. Their width was fashioned to give as unrestricted an exit as possible for steam, without being unduly uneconomical, and on that point I may specially remark that some of the present-day engines are not able to get the steam in or out quick enough at high speeds. The longevity of the cylinders has been largely due to the excessive clearance given at the ends of stroke for pistons, an evil which sprang from the desire to avoid injury to the cylinders and covers in the event of any of the five junk-ring bolts slackening back or breaking; and I notice in later practice that this has been avoided by using rings of a Mr. Ramsbottom's invention with solid-headed pistons.

One thing most worthy of note is that the weight of heavy piston-heads, and the oft-times unskilful manner of setting up rings with four or more crescent springs, coupled with the difficulty of obtaining constant lubrication, caused the cylinders to wear rapidly downwards; so that during my lifetime they have been twice bored out, and each time much to the edification of the drivers, who were delighted at the increase of power. . . . On the last occasion it was decided to bush them by the insertion of cast liners. This, I know, is never done now, and therefore the experience will be interesting. After the cylinders had been bored out a third time, the prepared cast iron bushes (or liners) were turned up to exactly the same diameter as the bore, and the cylinders were then filled with small pieces of wood and shavings, which were set on fire. The heat thus caused expanded the cylinders sufficiently to enable the bush liners to be forced in so fast that they never afterwards were the cause of the slightest bother. But on this occasion the diameter was reduced, and my power suffered in proportion.

It speaks well for the care given to my design and fitting that the cylinders, cast in halves and bolted together, have given no trouble whatever. The facing-up of each half was most carefully and skilfully done, and the pitching of the holes for the holding-together flange-bolts have more than justified the care by the result attained. The flanges and bolts were all external, so that the bolts were not subjected to the wasting influence of water or of acids from lubricants.

Before being finally bolted together, the faces were carefully painted with boiled oil mixed with a sprinkling of red lead, which not only prevented leakage, but also acted as a preservative to the faces. Some builders, I have heard, preferred to channel the two halves at joint and ends, and after bolting them together, caulked them full of rust cement; but this was considered by my sponsors to be an unworkmanlike method of making a joint.

The bushing out of the cylinders was not the only saving measure carried out to prolong their usefulness, for the port faces, although of splendid material, wore more rapidly by far than is the case now, as a consequence of the imperfect lubrication of those days—given (as it was then) in doses, and administered in the wrong place. Continuous impermeation of steam by lubrication was not known until I was almost too old to benefit by it, so that the valves were dependent on the steam film which formed on the partially uncovered faces; but at the top and bottom there was no relief, and absolute dryness with rapid wear was the result; and unfortunately, to make matters worse, large crescent-shape springs, some of considerable strength, were placed between the valve and buckle, with the mistaken object of keeping them on the face.

Should you be present at my autopsy, you will find steel faces, which were at first three-eighths of an inch thick, cleverly fastened on the old worn-down surfaces by means of cone-headed screws; and this operation was carried out under considerable difficulties, without separating the cylinders or taking them down. The patient and clever mechanic was a necessity of those times, and the original cost of a pair of cylinders in my youthful and adult days was at least double what they are now.

Cylinder wear is not confined to internal abrasion, for, in common with boilers, they are subject to rapid external deterioration by rust, occasioned by local leakages. The atmosphere of the smoke-box, when moist (and unfortunately this condition is too often obtainable from washing out, leaky mud-plugs, priming, etc.), produces, with the chemical action arising from wet ashes, a most rapid eating-away of all the neighbouring parts, and the crowns of cylinders, howsoever protected, suffer much. . . . My cylinders, long ere this, would have been rusted within breaking thinness had not the bushes supplied additional strength.

Note, they are provided with inside as well as outside covers, for practice had not advanced at that date to casting them with closed ends; and this was in one sense an advantage, for after I had the Ramsbottom improved pistons put in, the covers were plated on the inner side with half-inch iron, thus reducing the excessive clearance at the end of stroke. It was economical, but I heard afterwards that builders, thinking to profit by extending the principle further, made cylinders with ports a quarter of an inch narrower, with the idea that, if a five-eighth inch opening was enough for ingress at the greatest speed, it must necessarily be the same for egress, forgetting that steam, after doing its work and becoming reduced in pressure, could not possess the same liveliness. . . . The results were anything but comforting in their case, as high piston speed could not be obtained. . . . But I am again wandering. . . . The covers were secured to the cylinders by means of square-necked studs; the squares were provided to screw them into the cylinders, and to prevent them unscrewing.

Although a trivial matter, it was a decided improvement when round-necked studs were used, for they saved much labour. . . . Each outside cover had two handles whereby it could be lifted on and off, an operation only too frequent when the old pistons were in, as they constantly required setting up. . . . Fixed on the centre of each outside cover was a tap with a wide funnel-shaped nozzle that could be turned upwards for the purpose of pouring in the lubricant, which, unfortunately, at that time was principally Russian tallow. . . . But, indeed, everything of a greasy nature was acceptable to some drivers, from yellow grease to train-oil.

The custom was to pour the melted tallow in at a favourable opportunity when running with steam shut off. This was not without an element of danger, as the driver or fireman, seated on the buffer-beam with kettle in one hand and the handle of the tap in the other, at each returning stroke of the piston watched his opportunity, and poured the lubricant into the nozzle. It was sucked in with great relish, but rapid action was required to anticipate the forward stroke by closing the tap to prevent its being ejected. . . . Some drivers did not confine themselves to this alone, but would, on special occasions, prepare an extra *bonne bouche* in the shape of a large lump of tallow or yellow grease, and, dexterously opening the smoke-box door, drop it down the blast-pipe when steam was shut off.

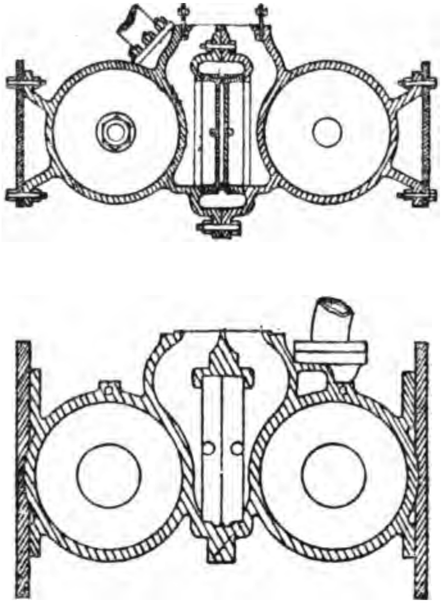
Now, when I look at the thoughtful and safe provisions made for lubricating every part, not only with steam on, but off, I feel that the engines should not only be much better and longer-lived, but the drivers themselves the most careful of men. . . . For myself, I was always grateful for these little improvements, which I valued the more for the personal desire to keep me right. I was never really envious but once, and that was when I saw that converted and rebuilt old scapegrace

Bacchus with his two spick-and-span new Roscoes on.

You will find few old veterans speak of their valves less than I have done, for I feel somewhat diffident in the matter, inasmuch as I have known some really good men go wrong on that subject. . . . John Gray and Timothy Hackworth—giants in their day—disagreed on the true functions of the valve, and Timothy and his brother would never allow any but themselves to overhaul the valves of the once celebrated Sanspareil.

Although believed to be quiet and unobservant, I have heard such notions propounded as would raise the hair of a mummy; lap and lead, linear and angular advance, all so misapplied, mixed and muddled, as to confound the cleverest perceptions; when all that was required was that the outside lap should be so proportioned as to give neither more nor less steam than could be easily and timely released by internal clearance—or, in other words, its quick and easy removal when done with.

Many times nowadays do I watch the coming



"Instead of a swift and easy-gliding current, chaos and resistance reign in that limited space" (*page* 33).

and going of the big wheelers; and although they are beautifully proportioned, I can realise the trouble they have to get rid of the waste steam, for every extra inch of cylinder beyond eighteen inches entails shallower exhaust chambers in the valves, which obstruct the easy passage of the steam from one port to the other. This will be evident if one notices the almost polished condition of the recesses of valves, showing the angle of impingement and refraction. Instead of a swift and easy gliding current, chaos and resistance reign in that limited space.

You will understand that from the first I became subject, not only to keen investigation, but also to treatment for the preservation of strength and energy. To prevent as far as possible any incipient decay, I was not only examined pathologically—that is, by the percussive and auscultation tests applied periodically—but at last one Mr. McNaught, assisted by Daniel Gooch, not satisfied with my *bona fides*, actually invented an instrument which they connected with either end of my cylinders, and worked out a diagram of the action of the steam, showing the admission, cut-off, expansion, and compression. . . . During this time I underwent many and pertinent alterations and experiments, which, I am pleased to say, resulted satisfactorily, and to the benefit of myself and my race.

I have a shrewd guess that, as with engines, so with mankind—it is the trivial annoyances which most affect us in the long run; and before leaving the cylinders, I needs must say a word or two about the glands. Many are the times that my patience has been exhausted and myself offended by the neglect of the commonest precautions of keeping tight. . . . The forgetfulness, or slipping out of the trouble, to go underneath and give the timely screw up, or when this was done so carelessly as to overtighten, or (what was still worse) screwing up unevenly. . . . What self-respecting locomotive engine could tolerate such things? From the slovenly, the neglectful, and the careless, we have most to apprehend.

Again, my glands have been packed in every imaginable way that mistaken ingenuity could suggest. When new, or after being re-bushed, good hempen gaskets well soaked in tallow were inserted, and were found sufficient, until a little wear somewhat increased the difficulty, and then some other material—preferably old rope, of a hard and implacable nature, well soaked or rubbed over with tallow—would be resorted to; but as the conditions became worse, more drastic measures would be again employed. Old hose-bags, composed of alternate layers of canvas and caoutchouc, would be cut off in rings and inserted, and so tightened up that for a time it would be difficult for me to move. Besides which, these abominations, after being screwed up in a most unmerciful manner, would pick up a metallic coating from the piston-rods, which grooved and fluted them until they were no longer amenable to any form of successful packing, so that turning up and re-bushing had to be resorted to. . . . At last came the endeavour to meet the difficulty by using metallic substances, principally composed of alloys, which should be neither too soft nor too hard, and which would not abrade. Some of these packings were a perfect study in conic sections, and nearly all with springs;

but a few were marked by the pleasing simplicity which in nearly every invention is associated with success.

We engines were all much interested amongst ourselves with the results, which varied like the packings themselves. Some would be hopefully tight for a few days, and then become hopelessly bad. . . . My own experience was very limited, but my interest in that of others remained the same.

The majority of these packings were composed of split rings of soft metal, which were forced into two cones by means of powerful spiral springs; others were of the solid block order; and others, again, of a composite nature —partly fibrous and partly metallic. . . . Some aimed at keeping the rods centrally exact as well as tight—that is, true to the axis of motion; and others believed in a floating packing, to allow for any divergence from the true line: but this, however good at sea, where, I hear, much freedom is necessary, is not the right thing on locomotives, as the piston-head gets too much freedom when running without steam at full stroke—so much so as to scrub and lash the body at ends of cylinders—and that is the reason of the extra wear at that part.

But the metallic packing is, when properly made, a great assistance and maintenance; for if you will examine my stuffing-boxes, you will find them lined with brass bushes, which became necessary on the inner walls being eroded by the oleic acids from the tallow and oils, which were so freely used to soak the fibrous packing. . . . . . . Yet good lubrication is the life of a good packing; and when proper provision is made for impermeating the steam, by means of improved Roscoes, or what are now known as sight-feed lubricators—all actuated by the principle of displacement—the local use of lubricants will be no longer necessary.

Some day, if allowed, I may explain more fully what effective lubrication means for a locomotive.

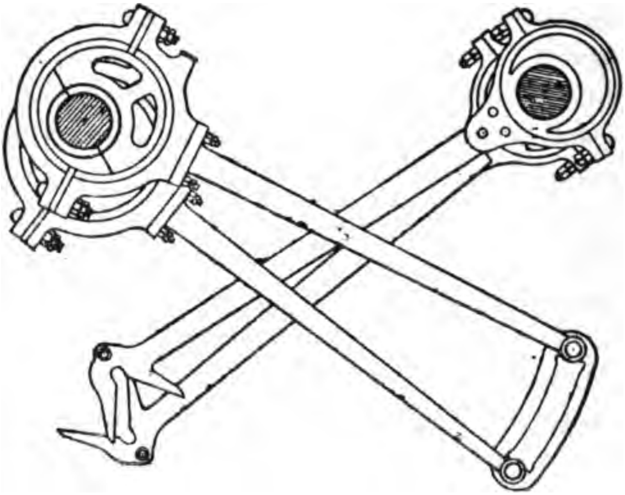
Age, infirmities, and pride, are at best a strange blend; but I certainly am proud to think that even in the most modern of my race I can recognise many features of the practice of my youth. . . . Don't forget that I was a product of the iron age, while that giant seven-footer close by, whose dimensions dwarf me so completely, is fortunate to be born in the steel era; and in this respect we are indeed a progressive family. . . . If I am informed correctly, wheels, frames, axles and boxes, pistons, cross-heads, boiler-plates, which make up my young friend's magnificent total, are all of steel, though necessarily of different qualities, and all of it no doubt guaranteed in strength to at least double that of my constituent parts. . . . Who would have believed in my early days, when the best Low Moor iron was in vogue, that the Bessemer process and the open-hearth systems would have been so fully perfected, and made steel so reliable? . . . My experience of steel is limited to my present crank-axle, my two former ones having been of iron, built up of slabs, through which, by reason of their want of homogeneity and of careful welding, the stresses and strains in time produced local weakness and fractures.

Now that I have time to moralise, I often wonder what would not have been accomplished by those great mechanical pioneers—Stephenson, Hackworth, and Gray—had they but had at their command the material which is now made so compliant and reliable for every want.

MOTIONS

We will now come to the motion, of which (I think) I have previously told you I had been proud, and, indeed (as I may now justly acknowledge) inordinately vain. . . . The cylinders, small as they are in proportion to modern ones, have, nevertheless, a splendid record of work done; and what greater satisfaction can man or engine require than that? Of the pistons, complicated as they were, I refrain from saying much, as they will not bear comparison with the modern ones, either in likeness or utility; or of the connecting rods, whose movements when slow were always graceful, and at speed so faithfully transmitted the power to the cranks. . . . Of all these and their doings I could with tender regard say much; but the motion was from the first the object of my closest solicitude and pride.

The curved slot-links, suspended so carefully from the weigh-bar, and so deftly coupled to the eccentric by the long and faithful rods, have delighted me by the countless movements made in varying travel. Their wavy evolutions, their graceful genuflections, wherever and however notched up, have always been a source of infinite pleasure to me. . . . During my manufacture, while in an incomplete state, I watched with the keenest interest and anxiety the care and professional pride bestowed by my designers in mapping out in full size the outlines, which afterwards, when finished to their satisfaction, became the working drawings. . . . The length of rods, with the best form of joint, giving the least indirectness; the form of butt-end which should be most stable and easiest to uncouple or line up;—all these things concerned them. But what chiefly concerned them at the time was the best form of expansion-link and method of attachment. Remember, at that time there was no particular treatise on construction written, and such experiments as had been made were kept profoundly secret. There was only limited experience to show which form was the best, and it took hours



"Link and gabs."

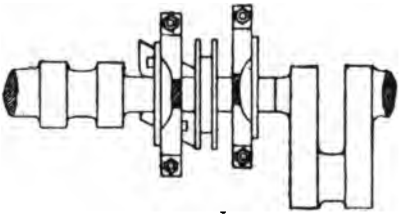
of anxious debate to decide whether or not the advantage claimed at that time for the box-link was not more than neutralised by its initial expense and maintenance. I sighed with relief when that form—so good in theory, so excellent on paper, so costly and ponderous in practice—was dismissed, and the open slot-link adopted.

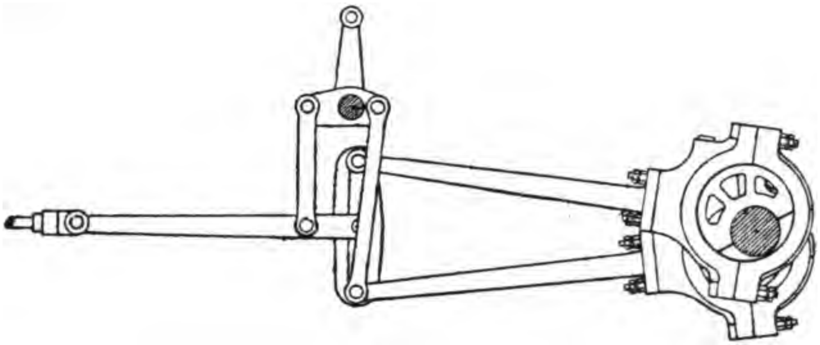
Then came the discussion as to the method of coupling up, whether the nearest approach to the advantages of the box-link could not be obtained by coupling on the back, in a line with dies in full gear, thus getting the centre of joints in line with the centre of die-block; but at last, after much cogitation, it was decided that the joints of attachment of rods should be above and below in line with the centre of die-block. Although this involved a little extra throw of eccentrics, and extra movement of those parts, and longer links, with assiduous care and planning the final decision was arrived at. The radius of centre of axle was put in, and when fitted, finished, and tested, they were a delight; and I can now testify that at no time during the fifty years of my existence have I experienced the slightest difficulty or hitch in working.

Many hundreds of times have I compared the beautiful results attained with other motions, perhaps more showy than my own, but none which I could admit performed so regularly the manifold duties required. Some of my companions could boast of excellence in one or two particular positions, but through the whole gamut of expansive movements and varying travel there were none to excel mine. From the strong, exulting beat at full gear to the gentle and sibilant chatter when notched up—indeed, through the whole scale—there were, as nearly as could possibly be obtained, a regularity and evenness of utterance that made one proud of the motion. Some motions, however correctly set, are never uniformly good in every position. Mine was the best; but even that did not constitute all, for the most careful provision had been made in bolting and pinning up the gear to prevent failure or breakage, or loose bolts in one side of the engine fouling and injuring the other; and besides careful hardening, to make still more perfect, every part of a joint, bolt, or eye, was provided with oil-holes or channels, which gave easy access for lubrication. The surfaces, whilst on a liberal scale, were not so great as to produce excessive friction.

I have, in years past, chewed the cud of reflection whilst being stabled in the company of other locomotives, some even fitted with the old fork or gab gear, having only two full positions. In later years I have seen and admired that beautiful compromise known as Allen's motion [*see next page*], which claims to give an equal lead in every position; but, knowing, as I did, that one cannot get steam on and off the pistons too quickly, I was always ready to back myself for a spurt against such.

But the most extraordinary (I think) of the lot was a motion devised by one Dodds, who,





"I have seen and admired that beautiful compromise known as Allen's motion"
(*page* 45).

discounting the use of four, made use of only two eccentrics, which could be moved laterally on the axle to any throw by means of wedge-pieces placed thereon. This system, which was built up on the excellent theory of exactest cut-off, so altered the lines of stresses and wear that it soon developed its impracticability.

Then again, just lately I saw one without eccentrics driven from the connecting rods, and the expansion produced by curved links rigidly fastened to the weigh-bar, which certainly can be applied under conditions impossible to mine; and although at the moment grieved at such a departure, I rejoiced, because it was the work of dear old David Joy, who from his youth had been true and loyal to all my class, but in particular to Jenny Lind.

In my own case, the eccentrics, beyond being worn a little oval, are even now in good condition. The smaller segments are made of the best wrought iron, case-hardened, and fastened together by bolts and cotters to the throw portions, which were made of the best close-grained cast iron. The straps are wrought iron, and were at first lined with brass, but some years afterwards were fitted with white metal, which has now become almost general in good practice.

You may take it from me that none of my descendants can apportion the steam to its several duties with a greater nicety than I can, so that my good fortune has been that I have had cylinders and valves with such liberal ports as to allow both free admission and release, under the guidance of a motion which controlled the quantities with great exactitude. I can only regret that my boiler pressure was not greater, for then the results would have been more manifest.

How true it is that the true artist is always in love with his work! Yet some people will still persist in treating the story of Pygmalion and Galatea as a fable. How can I ever do justice to the devotion and care of those who were responsible for my lineaments and construction? From the time that I was unsubstantially limned out in their minds to the day when the complete plan first took shape, and afterwards gradually grew to completion after being altered here, strengthened there, modified and coaxed to overcome difficulties, all was done by my makers under the inspiration and desire to achieve a creditable issue, with the best materials, and not for sordid gain. Self-interest took second place, and that at a time when there was no competition for the world's marts to incite ambition. Every conceivable difficulty of road, stress, or probable strain was conjured up, so that heads and hands might strengthen and girth up to the highest requirement so as to overcome it. Nothing of a doubtful or questionable character was admitted. It was not what would "do," but what would "do best."

Then, for my component parts, "merchant" and Staffordshire iron had no place, except for the most insignificant items, and only the best Yorkshire iron (and that of the Low Moor brand) was considered good enough for my constitution. There was no system then of testing for safety, for extreme elongation, or for breaking points. . . . Such was not needed. . . . It was sufficient to receive the guarantee of the manufacturer, whose word was his bond, and was sufficient for the fame of his brand. Reckless competition, and a ruinous desire to hastily amass wealth, had not undermined business reputations. Stability and long life were the trade marks with which manufacturers stamped their material, and their chief aim and object was to obtain a name and reputation, assured that adequate returns would follow.

Nothing was neglected that could conduce to this end; even the case hardening was not done in any perfunctory manner. . . . The material, encased in iron boxes, hermetically sealed, and closely packed round with bone dust, broken up hoofs and horns, was placed in furnace heat for eighteen hours continuously, and, whilst full-blooded with heat and carbon, was quickly plunged into a bath of cold spring water, the sudden immersion having the effect of not only testing the iron for flaws, but of striking the carbon deep and hard. Each box contained its "sample iron" to be broken, and unless the steeled surface showed at least one-sixteenth of an inch thick, the operation was repeated.

No wonder, then, that my motion only

required renewal of its bolts once in every ten years. . . . Even the axle-box and horn-blocks were all cast in chills, and the labour involved in such work was considered nought, so long as the results were good. . . . And the artisan who had been trained in such a school carried with him pride of place which no jerry work could eradicate. . . . But I am wandering again.

CONNECTING RODS

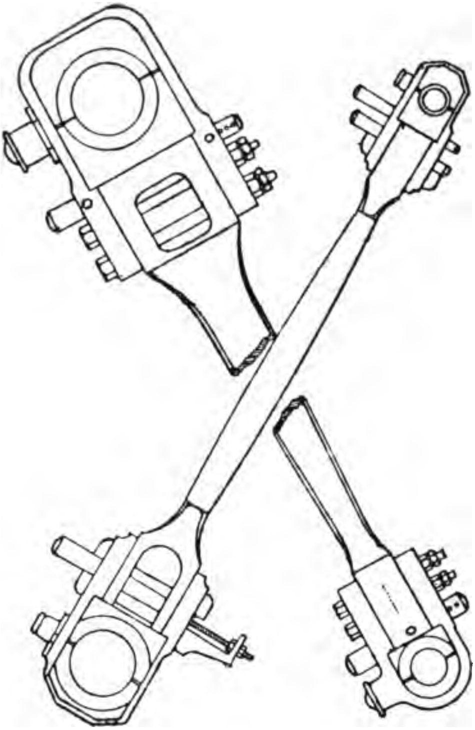
THE connecting rods I now have are not the same as were put in by the builders. The change was brought about by recognition of the fact that the parts nearest the cranks in high momentum, and subject to great wear, soon develop "knock," which had an unpleasant tendency of loosening the set screws and causing the retaining gibs to have end play, so that the straps were no longer in close and binding contact with the butt ends.

The original rods had straps fitted with hexagonal brasses, the connection with the butt end being made by gibs, and a long cotter with screw end, which was ingeniously contrived to pass through a loop of one of the gibs with adjusting nuts above and below the eye or loop, in order to secure it in the working position; but with all these addenda, the difficulty of securing it firmly to the butt caused it to wear rapidly. At last it was decided to make new rods, dispensing with the hexagonal, and substituting the square-backed brasses [*see next page*]; but the greatest improvement was the bolting of straps to the butt, and, instead of shortening the rods by cottering up the straps, to cotter up the brasses instead. This alteration gave me a confidence I had never felt before at high speeds.

I have heard it said that a certain J. Stephenson, of York, was the first to suggest and carry out this alteration. If so, in gratitude I tender this humble testimony of thanks.

The altered rods, when properly secured, banished all apprehension, and the only demands since made have been the occasional letting together of brasses, or their replacement when worn out.

You will already have noticed that my crank bearings are much less liable to heating than those made now, for with larger cylinders the space for journal every year becomes less, and the higher pressure per square inch on the bearing tends somewhat to the exclusion of oils of inferior viscosity. Indeed, were it not



"At last it was decided to make new rods, dispensing with the hexagonal, and substituting the square-backed brasses" (*page* 53).

that the pressure is removed from the front to the back brass twice in every stroke, the oil film could not live, and heating would ensue.

Previous to the introduction of the Babbitt soft metal, nothing but brass was used, and every maker and every railway professed to have its own mixture, which, successful or not, was proclaimed the best.

The secret of the constituent parts of the mixture was, as a rule, most jealously guarded, and no medicine man or maker of special nostrums was so mysterious as the professional brass moulder in making up the contents of his crucible pots. But one trial of the Babbitt, when properly applied, with its cooling unguential character, was enough, and the mystery man lost his functional position.

Nearly all connecting rods were for many years round in section, tapering somewhat from the centre to the ends; but when the influence and effects of sudden application and shutting off of steam were understood, the form was altered to the rectangular section, the rod increasing in depth towards the position of greatest disturbance and momentum, so that the rods (like your modern ones) taper from the large towards the small end only. Yet, after all, the success depends on the agency of the worsted trimming, an insignificant device, but one which no so-called improvement, however ingenious, has hitherto successfully put on one side.

I have known tallow to be advocated when forced into the oil-cups by the lid; but as a certain amount of heat was required to keep it in flow, the practice did not "take on."

Small clacks were tried with oil, the lift being regulated from the oil-cup lid; but no engine of staid habits could bear the irritating clicking which resulted.

Nothing can beat worsted and wire, and, as Tim Hackworth reproachfully told the driver of the Venus, the materials were always to be had wherever a woman's hair-pin could be found and an old stocking was obtainable to unreeve.

I do not hold by the adage that "a good listener is next to a good speaker." I, perforce, have had to listen hundreds of times to the most tiresome discussions between drivers as to the relative merits of ordinary tail-trimmings *versus* plug, and semi-plug, butterflies, and half-plugs. . . . For my own part, I was content with a moderate but regular supply of oil, however obtainable.

FRAMES

Now look at the framing, and do not be influenced by the comparative notions bred of later practice, for you must not forget that what the modern rolling mills now so easily accomplish in one piece was, at the time of my construction, considered a work of almost insuperable difficulty. The entirety of each of my frames represents several pieces—some welded, others riveted together; yet in outline and finish I can compare favourably, for strength, lightness, and efficiency, have all been obtained.

The bracketting has undergone some alteration, with advantage, and now the frames are rigid without being fast, strong without being too massive. As you will see, they are floating or travelling girders, carrying their incumbent weight without punishment, and have faithfully transmitted the innumerable relays of force which have for more than half a century passed through them without causing flaw or breakage. Cylinders, motion-plate, cross-stay, and drag-plate have kept them in lineal exactness, while the horn-blocks have been faithful guards to the axle-boxes, as well as points of thrust for propulsion.

Think, for one moment, of the tens of thousands of stresses of greater or less intensity which have passed through them! The second and third orders of lever have played their parts, and whatever difference in power there might be at top and bottom, the right and left have produced a balance, however light or severe the work might be.

Of course, this harmony of parts has at times suffered interruption by sudden reverses of steam and irruption of water in cylinders when in movement, which have no doubt put severe torsion strains on the axle, as well as produced sudden opposite stresses on the frames. Such incidents as these were to be expected in the life of an engine, with its many vicissitudes, occasional mismanagement, and liability to rough or ignorant usage.

Amongst other annoyances, I may instance those produced by shaky roads or badly worn points and crossings, which have caused rapid transmission of extra weight from one axle to another, so that the frames, under such conditions, were girders subjected to variable loads. No light affair this, when properly considered, and one which should speak volumes in favour of compensatory beams.

You will notice that my frames are stiffer between the cylinders and driving axle than elsewhere, and that utility has not been sacrificed for appearance, so that during the heaviest work I have never known any buckling or deflection to take place. As a result, the motion bars have never been troubled through any waist movement of frames.

But so much consideration had been given by the application of double-clip horn-stays, securely bolted to make good the break in continuity caused by cutting out the horns, that I never experienced any fear or other difficulty, even when occasionally off the road in bad places, or when the weight of axles has been suddenly transferred from the rails to the horn-stays. But much of the credit was also due to the excellent springs on which I was mounted.

You have already gathered that locomotives, like mortals, have their special weaknesses in silently comparing notes and drawing inferences. Well, I have seen really good, shapely engines resting on the worst of springs. I have counted as many as eighteen or twenty thin and narrow plates in one driving spring, short and deep, cambered like a horseshoe, stubbornness being the chief feature. No wonder that such frames have needed a constant renewal of bolts and eventual patching. Some springs were made with holes through the ends for bolts to pass through; others, again, were stirruped.

Really, at one time there was a great deal to learn in springs, and even now there is. Mine, as you observe, were broad, long, and not deep, sufficiently strong and easy in movement, without being too flexible, and with the least possible friction of bolts or plates. The spring links are hooked on, and are long enough to give an easy radius of movement.

WHEELS

THE wheels, as I have already remarked, are of wrought iron, and typical of the whole, and were built upon Day's process. The steam hammer, in my young days, was not generally known, for Nasmyth was only just developing his great steam forger. Therefore, every spoke of mine was forged with tippet hammer, and each Use, or spoke, really comprised a wedge at one end and a T piece at the other. The wedge piece constituted a portion of the boss, and the T-shaped piece, when united to its fellows, made up the rim.

The process of manufacture was very tedious and costly. When all the spokes were in readiness, they were so laid together that they formed a disjointed wheel, and were then encircled with a strong temporary iron strap or belt, on the ends of which were two lugs or flanges, through which a powerful bolt operated; and after this had been tightly screwed up so as to hold the pieces in position securely, the whole was laid on an "island hearth," and built round the boss with a coke fire. When the centres attained a welding heat, the encircling hoop was tightened by means of the powerful bolt, and the wedge ends of spokes were forced together, and thus welded by the constrictive force acting on the centre; after which operation a large convexed washer was welded on to each face, thus most thoroughly uniting the edges of spokes.

The welding on of the washers was a most interesting operation, for the rapid removal of the wheel from the fire to the block was necessary to ensure a successful result. The wheel, slung by axes forged on the belt, could be easily lifted when slung from a suitable crane, and turned over and deposited on the low anvil, round which the sturdy half-naked strikers were grouped in readiness. The smith, the presiding genius, with a long pointer, directed the torrent of hammer-blows here and there as required, and thus was consolidated the welding on of the washers.

Strikers were athletes in those days. Not only did they seem specially fashioned by Nature for their work, but each was trained for strength and endurance, and to fall out exhausted before the "heat" was over was in itself a physical delinquency. The V-ing up of the rim was a less laborious operation, but required greater skill in quick manipulation. The after-trimming up, preparatory to machining, was a somewhat tedious operation; but when all was done, the clear ring of the wheel, when suspended, and struck by the hammer, testified to the soundness of the whole.

Your practice nowadays is much improved. My tyres are *minus* the safety lips; and it may interest you to know that thirty years of my running were done with iron tyres, the majority of which were at first bent on rollers, and the ends afterwards welded together, blocked, then bored out—generally one-sixteenth of an inch less than the wheel—and then expanded by fire and fastened by contraction, one of the greatest severities practised at that time. Yet, not content, and as if to make matters worse, taper holes were drilled through tyres and rims, into which coned plug-bolts were driven from without, and either riveted or nutted on the inner side for greater security.

It was my good fortune never to fling a tyre; but I have known such a thing to happen through faulty material or bad workmanship, causing disastrous results. And no wonder, when you come to consider that at that time every tyre was bent from the bar and welded up. After the bar had been rolled to the ring form, the edges were scarfed and united by welding, either by pressure, or by the introduction of a wedge-shaped piece.

This method, however well done, left a strain on the tyre, in consequence of the local heating at the weld and the remainder being cold. The after general heating and blocking was not sufficient to restore a normal condition of homogeneity of fibre. It was an epoch when the first solid rolled tyres were made; but I must confess I was very doubtful, and for years I was suspicious of my first steel tyres.

The fixing of the wheels on the axles was at first a serious undertaking, and more reliance was placed on the keys than on the fit; but when, as in after years, this was done hydraulically, the keys were no longer held in reliance, and a pressure of from sixty to a hundred tons was considered sufficient to hold good. The key then became no longer an indispensable factor.

PUMPS, CLACKS, ETC

I CAN interest you still further with regard to pumps, clacks, etc., for the wonderful invention of Giffard was unknown when I came into being, and one-half of the troubles I had to contend with was in the blundering of thoughtless workmen. Sometimes it was in changing the clacks, all being of one size but different lifts, others being of different sizes and the same lift.

There were several varieties of clacks, as now, some of them being three-winged ones; but they had the abominable habit of breaking off at the head, often leaving the three wings jammed in the feed-pipes. There were the mushroom and the ball; but the ball-clack was an achievement when properly made, and when the weight and lift were not excessive. A compromise was sought by making them hollow; but this proved a greater difficulty than ever, for they were never of even thickness, and the balls would always gravitate and fall with the thickest side downwards, so that uneven wear defeated the object sought after. The solid clack was then again resorted to, and was usually placed in a cage screwed on to a seating, which was forced in and kept tight by an overhead set bolt screwed in the lid of the clack-box. Tar-band or whipcord were coiled in the grooves on the seating, and too frequently a slovenly fitter would make such lavish use of red and white lead to ensure the operation that special tackle in the shape of grapplers had to be used for drawing them.

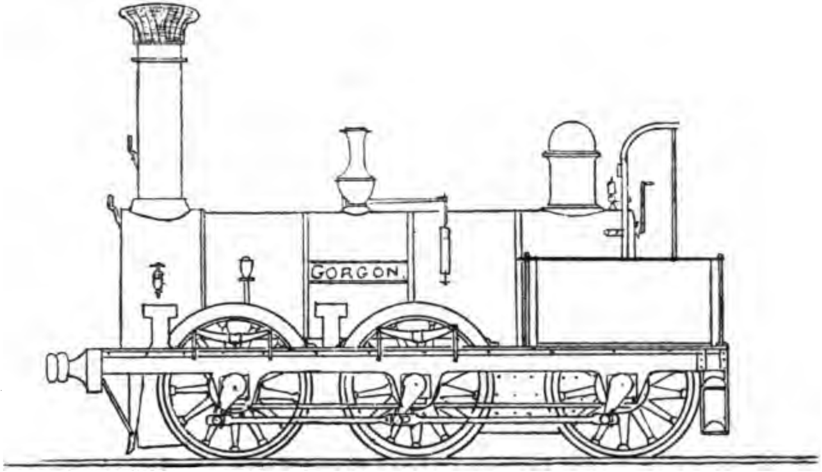
Then there was the difficulty of the set pins working loose or rusting away. With new rams and thoughtless drivers the joints would be blown out, but at last it became more generally understood that the size of the ram and the diameter of the feed-pipes should approximate. The difficulty of getting water into the boiler when standing remained, however.

INJECTORS

THE first intimation I had of the injector and its wonderful performance was through an old shed companion of mine, the Gorgon, a talkative six-wheeled coupled engine, very boastful [*see next page*], who assured me he had seen the Pluto—one of Sharp's latest contributions—fitted with an apparatus that fed the boiler without moving, and that the operation was conducted with so many preliminary snorts, accompanied by jets of water and steam, that he was sure no reliance could be placed on its use.

After that, rumour and speculation were rife amongst us until the Minerva was fitted with the new apparatus, and tried, much to my gratification, on the next pit to where I happened to be washing out.

All were agog; but I was most struck with

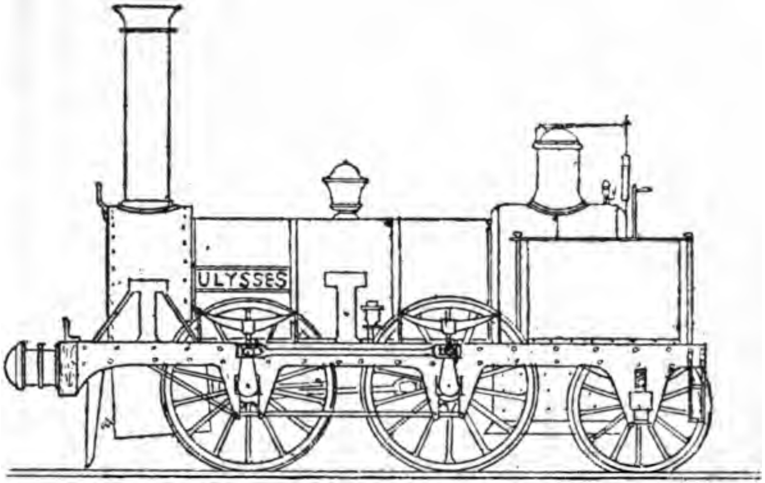


"The Gorgon, a talkative six-wheeled coupled engine."

the conduct of the old Ulysses [*see next page*], who, too wise and proud to show his astonishment, nevertheless actually burst a tube with suppressed excitement on hearing the song of satisfaction sung by the injector at getting successfully to work.

When, twenty-five years ago, I had my first injector fitted on the left side, many of the trivial annoyances of life vanished, and the irritating necessity of running backwards and forwards in order to fill the boiler was no longer known ; but after all, where the pump could be worked skilfully, the supply could be more accurately gauged to the demand. So, you see, few blessings are unmitigated.

How many times could I instance, when, blocked up in sidings, and water was needed in the boiler, I have been for the time deprived of adhesion by the liberal use of oil on the rails and under my drivers, with the brake hard on? No more pitiable sight for men and engines could be seen than a single-wheeler like myself transformed for the time being into a stationary merry-go-round.



"Old Ulysses, too wise and proud to show his astonishment."

BOILERS

THE present one is my third boiler. My first lasted for twenty years, and my second nearly that time.

I have already alluded incidentally to the experimental demonstrations which were made by the "Alexandrian" during the joint reign of Alexander and Cleopatra, and which no doubt invested him with almost supernatural attributes; but I must crave the indulgence to remark that it is at least most complimentary that, from the very first inception of a mechanical motor, steam was selected as the agent.

But my ancestors of that day were in imperfectly defined conditions, and suffered from spherical development of boiler. That part of the system, made of bronze, was ill constructed for the transmission of heat, which was produced by putting (what we should now call) an Argand lamp underneath. The sphere, which was fixed on upper and lower axes, rotated by the reaction caused by the steam escaping from the contracted outlets in the curved arms on its meridian line.

Owing to the demolition of the Marquis of Worcester's pet child—which, as I informed you, was anathematized by bell, book, and candle—there is no record of the shape of his boiler; but, coming down to the time of Cugnot, you will find that the semi-rotund shape found favour with him also. Trevethick, Hedley, and Blenkinsop, being much more practical in their ideas, adopted the cylindrical form of boiler, which, after many ingenious and internal developments, and contortions of single and return flues, was brought to its present state of efficiency by the use of a large number of small tubes—an idea which has been ascribed to a suggestion made to Mr. Stephenson by Mr. Booth, the then Secretary of the Liverpool and Manchester Railway.

I shall not be able to explain the difficulties that had to be overcome in the making of my original boiler, built up (as it was) slowly, piece by piece, section by section, forced and held together by bolts, cramps, and pins, until the needful riveting was done. Even now I can almost hear the ring of the hammers as they played around the pointed rivets.

It is to be regretted that my outer casing, rust-eaten and dishevelled, with bands awry, does not allow one to see the combination and union of plates which for so many years successfully controlled forces of which the generality, happily, have not the slightest idea; for the subtle elastic element, so insidious and persistent under pressure, searches for egress at every joint, seam, and rivet. It allies itself with other forces, principally expansion, and safety can only be obtained by allowing a judicious latitude to the latter. At the most moderate calculation, with only 100-lb. pressure per square inch, the total collapsing and bursting pressure amounted to 7,212 tons, and with 120-lb. it amounted to 8,654 tons.

I have been often amused at the alarm I have created when vigorously blowing off at the safety-valve—a healthy sign with a good constitution; for I may say I was ever trustworthy when dealt with fairly, always possess-ing a margin of strength much beyond the set pressure. However, when I fell into the hands of the thoughtless and devil-may-care sort of drivers—who, ignorant of all but the phenomenal strength obtainable by increasing pressure, would, in defiance of all rules and regulations, goad me on by loading me with extra weight on levers—I confess I was at times run very close to the safe-working load of my tenacious Low Moor plates.

Under such unjustifiable conditions I have been made to climb banks at a speed out of all proportion to the load behind, with the needle of the indicator at its maximum registration stop, whilst the hilarious tormentors in charge have claimed credit for the performance. I have been at these times most reasonably anxious for the flat surfaces of the fire-box, inside and out, which, relying on the four-inch pitched stays, true in alignment, and loyal to each other, testified to the wisdom of the Stephensons in designing that pitch, which to my knowledge has never been departed from, and it showed an intuitive grasp of what was really necessary. Some people nowadays would egregiously call it "rule of thumb," rather than judgment. Bah!

Each suffering patient knows best how he feels, and at times, when exasperated by ill-usage and tempted to rebel, I could almost define the exact locality which would be first to yield to resentful impulse. The tube-plates, supported as they were by the tubes, I knew would bear anything with patience; but not so the barrel-ring on which the dome was fixed, for that was already robbed of its continuity of resistance by the size of hole over which the dome was mounted. An explosion there would have eviscerated the interior. Nor was I more assured of the sides and ends of the copper fire-box, for the material, when heated, lost, I knew, a considerable percentage of its power of resistance, and when worn thin from the fire-level downwards they were liable to release themselves by slipping over the diminished stay-heads. But you can believe me that nothing short of the most reckless ill-usage, neglect, or malconstruction, will cause a boiler to burst; and yet it is only by an occasional explosion that one can impress the mind of human beings with the stupendous capabilities of steam, and the necessity of thoroughly understanding its management.

In our boilers especially we are a patient and long-suffering lot, and neglect of them is ill-treatment, for at those places of greatest generation we are liable to become fouled, and most careful washing out and examination are required. Our fire-boxes, you see, are also subject to great variations of temperature, which try the temper of the plates severely. I have known a difference of a thousand degrees of heat to occur in twenty minutes in a fire-box, and this, too, when surrounded by a sea of pressure.

With the outer plates of iron it was of little moment, as their strength, although not generally known, increases 20 per cent. up to 500° Fahr.—a strong argument in favour of higher pressure.

Now that I have nothing to do but moralise, I often think of my young days, and compare the work done then and now. Experiment had not then proven the correct pitch and diameter of rivet for the given thickness of plates, yet the men of that period intuitively came so near to what experiment afterwards laid down as a law that it appeared more like a confirmation of old practice than anything else.

Of course, as I have long seen, the boilers are now plotted out in the flat, and, after being bent, are riveted up with steam- or water-power. But my first boiler was riveted from end to end by hand, and the skill and desire of the workmen to finish up the pointed head, even when the red glow had disappeared, might have caused the rivets to often become brittle.

I was not slow to acknowledge the advantage of the deep-cupped head, particularly when hydraulically made, as the plates were not only closer, but the holes better fitted; but what I particularly felt, and yet was not able to alter, was the barbarous caulking applied to seams and edges of plates in those days, which not only disfigured the work, but put on an initial strain, in ill keeping with the principles of boiler-making. Some of the lighter plates, positively, were appreciably *lifted* by unscientific caulking at the edges. I see now that the edges are planed at a slight angle, and, when finished, the gentle application of a fullering tool is (or should be) all-sufficient. Interior caulking is my chief abomination.

My second boiler was materially injured by erosion after a few years, caused by the skin of the iron being broken by the heel of the caulking tool. My boiler had a hundred and eighty brass tubes, two inches in diameter, and that particular feature was a centre of attraction. But I was proudest of the dome, which, although riveted up the side, and having angle irons top and bottom and somewhat rough, was afterwards cased in by a specially handsome brass cover, which, when polished, became the envy of all other engines.

You will hardly believe that the discoloured and dinted and even commonplace-looking article which still remains was once more refulgent than the bronze helmet of the hero whose name I carry.

The barrel-plates were numerous, each ring consisting of two plates with horizontal seams, which, I have heard afterwards, were not considered the right thing, in consequence of a knuckling action, which, at high pressures, assisted in producing grooving, as they were below the water-line.

Mine, however—in which the outer shell of fire-box was united to the barrel by means of a specially shaped angle iron, in section somewhat like the letter Z—never caused any trouble. The outer shell was composed of three plates, one on either side, and one crown sheet, over which a small manhole was placed, fitted with a lock-up safety-valve. The front plate of shell was united with an ordinary angle iron of strong section, and riveted to the side plates and crown. The foundation ring was of similar Z-shaped angle iron, but of stronger section, giving a water space of three inches.

The stays of side, front, and back, like the plates, were made of best Low Moor iron, riveted on outside only, square heads, by which they were screwed into plates, being left intact on the inside. These squares were occasionally burnt off; yet I attribute the longevity of copper plates to the protection they afforded against the scrubbing action of the hard coke (Pease's West and Brancepeth) with which I was fired at that period.

One peculiar feature I cannot refrain from instancing was the immunity I enjoyed with this boiler from cracks between tubes in the sides of the tube-plate, which was due to a number of circumstances of which at present I have no time to make a record.

I must now instance one serious mistake which at that time was universally made, and under which I suffered—as stoically as I could—for many years. You notice the two projecting brackets, one on either side, which are riveted to the outer shell of the fire-box. These, previous to the last alteration, had the frames bolted thereto, without any allowance whatever being made for the expansion of the boiler when under steam. Many times have I expostulated in my own silent way, but as forcibly as I could, against the want of judgment in doing this. Broken bolts, and stays in fire-box side, were frequent, and, indeed, had not my frames been united as substantially as they were at the bottom of horns, they would have broken at the upper corners.

At last my practical remonstrances were understood, and the cruel bolts were with-drawn and expansion plates substituted, which placed the frames practically free of the boiler. My lot, however, thanks to the closer study given by constructors, was not nearly so hard as that of many of my colleagues, for, so far as opportunity would allow, I have always been somewhat observant, and I can assure you that I have seen many engines so constructed at that time as to *pull from* the boiler—that is, the side plates of the fire box shell were extended beyond the front, and drag-plates riveted thereto. Indeed, one well-known engineer used to put flanged plates on to the firebox-shell front which carried the drawbar.

If you lift up the old flap-plate, you will observe that I have my drag-plates put on between the frame ends which project beyond the fire-box, and which form the intermediate buffer-beam as well.

I must remind you at this point that my first boiler was pressed to 100 lb. per square inch. My original tubes gave me but little trouble until they had been regularly at work for five years, when, as I was going up Highstead Bank with a heavy load, one burst with a loud report. Even now I cannot but feel amused at the consternation shown by my driver when this occurred; but, happily, after the first shock, he pulled himself together, and soon proved equal to the occasion. After uncoupling me from the train, which he had braked to prevent running back, he ran me forwards and backwards to keep the water up by means of the pumps, during which time the fireman had secured two suitable wood plugs, which were driven in when the pressure had somewhat abated.

I had many such unpleasant experiences afterwards, until an examination revealed the fact that the tubes were worn too thin at the fire-box end, and also at other localities where dirt had at times accumulated.

As an engine, I cannot but repine that, with the ripe experience which I have obtained by work and observation, I should now be cast on one side.

When the tubes were taken out of me, I noticed that the brass was always much corroded and worn just beyond the ferrules at fire-box end, only for about an inch and a half —indeed, so thin as to cause collapse or bursting to take place; but the outer, or water, side, when the coating of incrustation was removed, was as good as on the day when put in. This I understood to be the result of non-affinity of the outside with the chemical constituents of the water; whereas in the inside the depreciation was due to two agencies, one mechanical and the other chemical, each aiding the other. The action of the blast caused the small *detritus* of coke to impinge with abrading force at an angle just within the ferrule, and the erosive chemical action was due to the sulphuric acid gases arising from the moist coke.

The whole of the tubes did not suffer to the same extent, the worst cases being in the middle and upper rows, and the side tubes showing little wear. This was due to partial diffusion of the gases, owing to imperfect action caused by the ill-positioned blast-pipe, of which more anon. Beyond the ends which suffered, the remaining lengths of tubes were good, and this caused the suggestion of brazing on new ends, so as to allow the remainder of tubes to be worn out.

While on the subject of tubes, I cannot refrain from mentioning the extraordinary development which in my time has been made in tubing boilers.

I have before hinted at the opportunities afforded to locomotives, when stabled together, of indulging in comparisons. These would not be altogether odious—nay, at times very much to our mutual advantage, for good points in construction, and the excellency of the work done, always proved a fruitful theme of conversation.

The most striking feature was the ever-growing desire to abandon the two-inch tube, and to insert as many tubes as possible of small diameter, in forgetfulness or ignorance of the fact that, in order to make them operative, greater blast-pipe energy was required to separate the products of combustion, to say nothing of the extra gas friction involved in the operation; such increase in vacuity amounting at times to as high a figure as six or eight inches, which meant increasing the velocity of the heat-current beyond the possibility of economical absorption, besides loading pistons with back pressure to an extent that defeated the very ends sought after.

In theory it appeared the correct thing to break up and divide the heated gases into as many parts as possible, in order to absorb the heat; but practice (which, after all, is the great teacher) told a different story, for the velocity required not only prevented full absorption, but, by centralising the draught, prevented the more general diffusion of gases through the extra number of tubes put in. Just imagine tubes—say—one and three-quarters of an inch in external diameter, still further contracted by insertion of ferrules one and a quarter inches, each ferrule projecting beyond the tubes, and hindering the ingress of the gases, and the velocity imparted to such being so great that a portion of the length of tube, and that the most valuable, was never perfectly filled, for the ferruled diameter, as the *vena contracta,* was the gauge of its admission. With less blast-pipe energy the results would have been better. That a more equable diffusion is not possible

—particularly when the one and a quarter inch diameter suffers further contraction by the fouling up of ferrules, consequent on the use of certain coals, and small blast-pipe orifices, and wet weather—is apparent. The total calorimeter of small tubes is much less even in crowded boilers than in those which are not overstocked by tubes of one and three-quarter inch internal diameter. In fact, the boilers have not sufficient breathing space.

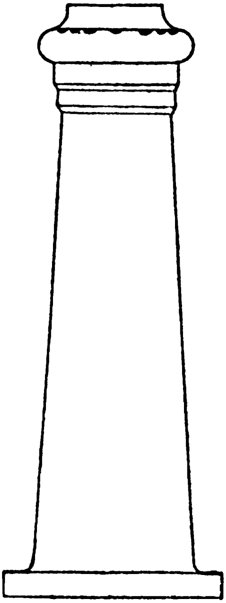
The error of using tubes of small diameter became general in time, and in spite of the fact that the results were not equal to expectations. I now hear that a change for the better is taking place.

Another feature I rejoice to observe as coming to the front is the enlargement of the barrel of boiler to its greatest possible limit. This would, of course, allow of steadier water, less disturbance, and drier steam, much less invisible priming, and also greater reservoir of water and steam, which is much required in these days of long runs and high pressures.

SMOKE-BOX

I TRUST you will believe me when I assert that "the boiler makes the engine." But however well-proportioned the boiler may be in capacity and heating surface, unless the smoke-box and blast-pipe are right in size and position, the results will not be satisfactory.

Of course, this is the third one I have had, and I can now speak from experience. The first two were of the same length as the present one, but not so high; for the third boiler, although of the same length, was lifted three inches higher in frames, which not only contributed to a more imposing appearance, but also allowed of a deeper angle iron on which to rivet the smoke-box. The extra range in height and width gave me also more capacity for the inhalation of the products of combustion, and with the most surprising results, for I was able to steam with a freedom formerly unknown, although the grate, firebox, and tube areas, were the same; and I have not the least doubt that even better results would have accrued had the exhaust-pipe not been some inches higher than the top row of tubes.



What follies have I not seen perpetrated in my time as regards blast-pipes! some of them poked right into the throat of chimney, others put in at haphazard, without any attention to centring or directness.

I have heard men who ought to have known better talk by the hour the most insane twaddle, when a little close reasoning would have led them in the right direction. For years a heavy, stertorous beat was believed to be an indication of strength. By some drivers I have been mercilessly hooked to the point of congestion and physical exhaustion, until the vacuum has ranged from six to eight inches, and the temperature in smoke-box ran up to furnace heat—all with the idea that such means were steam-producing, ignoring the fact that they had to pay exactly the same price for its production in back pressure.

Of course there is a mean, which, when arrived at with a properly proportioned blast-pipe, is a success; but this was not understood, and—from what I can gather by an occasional glimpse at alterations made to my younger brethren—there is still diversity of opinion and still very much to learn.

I can only say that many of the physical disabilities of engines would be removed if smoke-boxes were made larger, and blast-pipes lowered, so as to produce a more uniform range of draught, which would at once have the effect of reducing the vacuity to two inches or under.

Smoke-box doors and their fastenings should be as simple and air-tight as possible. My first doors were togged with a number of catches, in order to hold them tightly against the front plate, but this would not prevent distortion where small blast-pipe orifices were used. It was no uncommon thing to see drivers stopping on the road and claying up such draught-holes. Indeed, fire-clay for the doors, and bran for leaky tubes, were part of the outfit provided by some drivers. Now the convex door and the central bar meet that difficulty most handsomely.

CHIMNEY

ALTHOUGH responsive to your sympathy and interest in many things about me, I feel somewhat amazed at the careless glances you bestow upon my chimney. Remember, as the hat is to a well-dressed man, so is the chimney to a locomotive. Although battered and worn more than any other part, I still cling to it with affection. It has always been upright and to the front during the changing years. Like the figure-head of a ship, it has borne the roughest usage, wrestling with the rain, snow, and tempest in winter, but laving and cooling its sides in the gentle breezes of spring and summer. Shabby it may appear now; but you must remember that the chimney shows seediness sooner than any other part of a locomotive.

My first chimney was a wonderful erection. Sturdily fixed (as it was) on a square plinth-like base fitted to the top of smoke-box, I was very proud of the inverted bell-shaped top and the two ornate-looking collars which united the top and bottom to the barrel part, while in height it towered at least six inches above the range of the present chimney.

Adaptation and custom are strong but efficient teachers, and what we deride in others to-day we tolerate and admire in ourselves to-morrow. I felt it a great indignity when I was fitted with a shorter chimney, *minus* the square plinth-like base, in place of the old one, in consequence of the enlargement of the smoke-box. But custom, the great converter, at last not only reconciled me to the change, but led me to find pleasure in the new head-piece. In practice, I do not personally object to a long chimney, where height is no object, but in such cases the diameter may, with advantage, be somewhat larger than that of a short chimney.

My first chimney was parallel in the barrel part. My present one is a little smaller at the bottom than at the top, which also I have found to be an advantage.

One of the chief features in a good chimney is to provide an easy curved entrance from the opening in smoke-box to the barrel part, so as to facilitate the outward flow of gases. Moreover, it should be fixed as plumb as possible, so as to be true with the centre line of exhaust.

I remember with what vexation I was running *for two years* with my chimney nearly two inches out of centre, until I was fortunate enough to catch the fastidious eye of our then foreman-fitter, who had it adjusted, much to his and my own satisfaction. I ever afterwards had a kindly feeling for the man, more particularly as he was the first to fit me with a steam jet, which (although horribly annoying with its noise for a time) proved so powerful a stimulant and pick-me-up, that I never afterwards underrated the value of what appeared a trifling alteration. As you will have gathered, I have had several chimneys in my time, but I refrain from mentioning more than the first and the present one, for the others were constructed with no other idea than of being merely conduits for smoke, as though that was the only object in a chimney's life.

And although weather-beaten, blurred, and rust-eaten, with the japan flaking off here and there, and having one side worn through by misdirected exhaust, my chimney has been not only a useful but a jaunty mounting in its day, and, more than that, endorsing most emphatically all I wished to say, and taking no unimportant part in the pride of place and office which every portion of a complex whole should feel.

Cast-iron chimneys are now in fashion, some straight and others tapering, and both with and without outspreading tops. I have little patience with those who cannot see the desirability of relieving the top by putting some little tasty finish thereto in the shape of a capital. For chimneys, one can understand the advantage of cast-iron as the material, not being so sensitive to rusting and internal corrosion. That once promising man, J. Stephenson, of York, was the first to introduce them in cast-iron, as well as cast-iron firebars, and I often regret that so devoted a worker should have passed away at an untimely season, before proving to the world his capacity for greater things.

The safety valve funnel, itself a miniature chimney, entirely made of good yellow brass, resplendent as the helmet of a dragoon when well polished, was fitted over the manhole, on which were mounted the two safety valves with levers projecting over to the front, and weighted with two pleasant-looking Salter spring-balances. It was most soothing to hear the gentle metallic sound of the escaping steam blowing through the casing.

My drivers, however, had a knack of making the ornamental safety funnel useful; and many a juicy steak or chop, well wrapped and tied up in paper, have I seen suspended by a wire from the top, and cooked in the escaping steam to a perfection unknown to any other process. To judge by the unctuous relish shown in the eating of such dainties, especially when accompanied by potatoes baked in the smoke-box, this piece of cookery appeared to transcend anything obtainable from the "shovel grill."

The position of the levers was an ill-advised one, as I have known many times to my cost, for no greater temptation could be offered to ignorant or reckless drivers to put on extra weight in ascending banks with heavy loads. Indeed, I have known drivers who have carried wedges in their pockets to insert between the weather-plate and the tops of safety-valve levers, and others who kept a couple of spare links conveniently by for the same purpose. No expostulations on my part could prevent such usage at times. In engine language I have hissed and snorted my protests, but only to cause such drivers to re-double their attempts to still further strangle efforts at complaint.

WEATHER-BOARD AND AWNING

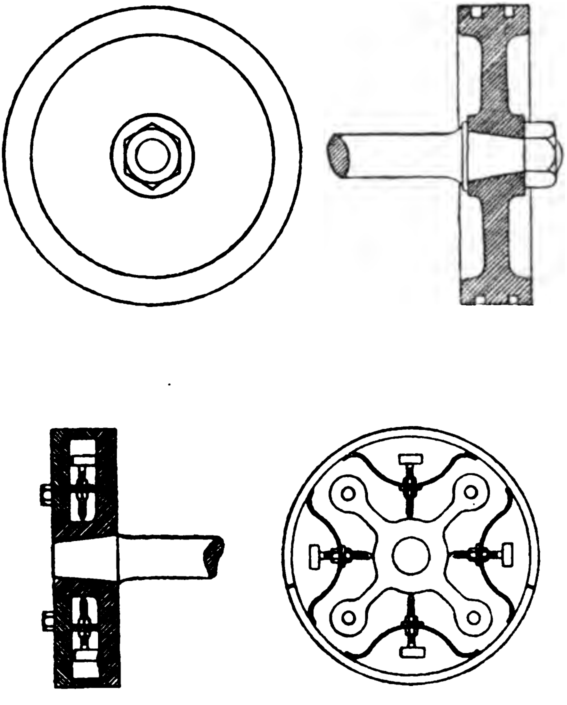
ALTHOUGH retaining many of my old features, I have (as you know well by this time) undergone many alterations in detail; and the one which has effected the greatest transformation in my appearance is the awning. At first, the only provision made against the weather was a plain-looking weather board (a misnomer, as it was made of sheet-iron), twelve inches in depth and three and a half feet in length, pierced with two six-inch holes, into which plain-glass discs were fixed. This was the only shield against the cutting winds, blinding rains, sleet, and snow; and I have known both drivers and firemen to be half-blinded and partly frozen in bad weather, with their hair and beards matted with sleet and snow.

My experiences of late years have almost led me to forget the misery and discomforts suffered by drivers and firemen before awnings were erected, and therefore the present generation of enginemen have not the slightest idea of the privations which were suffered by their predecessors years ago. And this, not only in the matter of protection against weather, but also in the hard and constant work required, particularly at the hands of the firemen; for the adoption of the steam and other powerful brakes, with which I see nearly every engine now fitted, renders it no longer necessary to strain at the wheel or handle in order to control and regulate every stop.

INTERNAL DISSENSIONS

THERE are times when every respectable and thoughtful member of society should take counsel with himself, and undergo self-examination and inter-communion. With me, it was not only advisable, but a necessity, for the constituents of my whole, when discontented, had the ability of preferring their claims in a manner more complicated than agreeable. Confidentially I may say this was my sore point, for whilst personally endeavouring to maintain the closest relationship of parts, I was so unfortunate as to offend the *amour propre* of several. Whilst professing the most uncompromising loyalty, I have known several of them to be on the verge of sedition.

The pistons—notorious grumblers at best of times—at the slightest provocation have frequently complained that, as a consequence of being boxed-up and hidden from observation,



"The pistons—notorious grumblers at best of times" (*page* 101).

they did not receive the attention to which they were entitled by virtue of being prime movers. Further, they would justify their groaning and whistling by reason of the ungenerous treatment which they alleged they received at the hands of the valves and boiler, whom they charged with collusion, asserting that they had been constructed solely for steam, and not for hydraulic purposes. But sooner or later harmony would be restored, when it was understood that neither the boiler nor the valves were responsible for neglected feed-pumps, bad water, or unskilful handling or lack of lubrication.

Then the connecting rods would have the audacity to take up the grumbling, and state that, although willing to do all that was required of them, they could not help thinking that no other members of the body corporate had so much to do as themselves. Remorselessly coupled, as they were, to the crossheads at one end, and to the cranks at the other, the pistons would put them under alternate compression and tension for hours, and then suddenly and without notice take off the load, allowing them to be hurled backwards and forwards by the ungovernable momentum of the cranks. Further, they would instance the ninety degrees angular set of the cranks, which could never ensure that co-operation to which their highest efforts were given.

Even the sluggish slide-bars irritated each other by ungenerous comparisons, the top roundly asserting that the bottom one was but little good, yet shared greedily in the lubricant.

To point out the fact that duties could never be so evenly apportioned as to meet with general favour, was an easy matter for me, but not conclusive to them. So I adopted the policy of instancing examples of other portions of our common mechanism, which unmurmuringly took up duties of the severest character —to wit, crosshead and valve spindle cotters— which, although not showily placed, modestly and uncomplainingly bore shearing strains of the most trying character.

Not infrequently the axle-boxes and horn-blocks made a joint representation, calling the driving axle as a witness that the work was not fairly apportioned in the top and bottom halves of the stroke; hence the uneven wear and knock.

The boiler alone—who had more substantial causes than any to complain of ill-usage, neglect, defective circulation with unequal expansion, excessive rises and falls of temperature in fire-box, trials from without by corrosion and from within by erosion, attacks from native and imported acids, and at times overpressed in the most barbarous manner—roundly swore that, beset as he was, he would rather burst than complain.

Then the driving wheels, forgetful of the ties of mutual interest by which they were bound to others, authoritatively claimed the right to be heard in preference to all else, on the ground that through their agency only was locomotion possible.

As a preliminary, they wished it to be understood that they spoke for themselves alone. "We must not be judged," they said, "as ordinary wheels, as we decline to be associated with either the leading or the trailing ones, which are merely weight-carriers. We *propel* as well as carry; on us rests the onerous and primary duty of traction, and that under difficulties unknown to other parts; no portion of the machinery has to bear such strains and stresses as it is our lot to suffer. Appearances are deceptive, for although seemingly a harmonious and compacted whole, we are not so. From the first we have been the victims of force. During the process of construction we were welded together by force, with the result that normal strains are existent in our rims and bosses. We were forcibly united to each other through the medium of a despotic crank-axle, to which we were bound by hydraulic pressure to prevent independent action, and further secured by being locked fast with keys. We have been the subjects of the most unskilful treatment ever since. For many decades we were the victims of almost incalculable constrictive pressures, which, in some cases, were enough to visibly warp and bend our spokes, no elasticity being left in us. Our rims have been ruthlessly bored through. We may be resonant, but are not resiliant. We do our daily work, although troubled with disruptive forces at the bosses and constrictive pressure at the rims. We unite the opposites. Held in forceful contact with the rails by a surface of touch almost infinitesimal, with such meagre foothold we do our daily work. All day long we either indurate or abrade; we are subjected to unequal movements of force; our peripheral speeds are dissimilar at top and bottom; and our regularity of momentum is borrowed, although counterpoised with heavy weights. As for our adhesion, that is a variable quantity, to suit the weather. Subjected to human caprices, and to the violence of bad tempers, our lot is anything but a happy one."

On one occasion, to finish up, they became recriminatory, and accused each other, and not without cause, of unequal adhesion at trying times. But they soon made up that difficulty by uniting and entering a joint protest against the sand-boxes, which they averred were not properly placed, and did not work together or give an equal supply. As a result, simultaneous sanders were applied.

Comparisons, however carefully or skilfully drawn, are always disturbing, if not hurtful, and I felt sure that such injudicious remarks by the driving wheels would incense or provoke those otherwise patient weight-bearers, the leading and trailing wheels. I was not far wrong, for the leaders took upon themselves to reply, spiritedly addressing their neighbours as follows :—" We, as representatives of the great body of weight-carriers, feel indignant at your unmerited imputations and unwarrantable assumption of superiority.

" Whilst admitting your right to claim credit for traction, which is due to the accident of position, and the good fortune you have had to be united by a crank shaft, the only difference between you and ourselves in all other respects is your unpardonable pride of place. Although the duties apportioned are somewhat different, you must not forget that we spring from one common source, the history of which it is as well you should remember before you presume to rebuke others. In tracing our commencement, we trace yours."

They proceeded to give a brief account of their family history, which I will try to produce in their own words.

" Like all durable institutions," they said, "we were evolved slowly, and the evolution is not yet completed. Our origin dates back to Kluga the Cave-dweller, the maker of flint weapons, the swift runner and hunter, the slayer of Malyun the Bear. Our primal condition was the round straight smooth bole of a forest tree, which caught the eye of the Flint-breaker, in search of material for an enlarged idea—namely, the moving of a ponderous stone wherewith to partly block up the entrance to his cave, his place of refuge when chased by Malyun.

"In time the flint axe did its work, and the two-strides length of timber was trimmed and carried, by the aid of Kaglas, to where the glacier-splintered rock lay. By mighty efforts, often disturbed by the vindictive Malyun, they heaved up the huge stone and placed the roller beneath; and with frequent renewal, after many days they prised and lowered it into position, and so ramparted it as to admit only themselves, and to bar the entrance of Malyun.

"The forest architect was forced to devise this plan by the crude instinct of self-preservation. In the passage of time the growing intelligence of his descendants suggested that, to increase the speed of such operations, discs of wood of superior girth, and bored out, should be loosely fixed on the ends of rollers, which, when done, constituted the first of our kind.

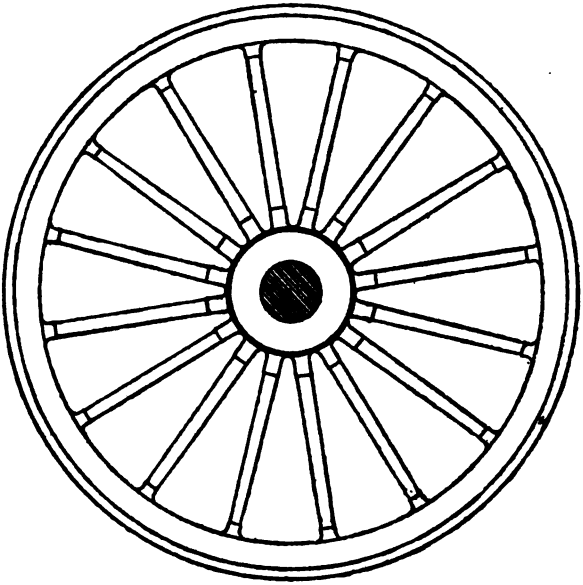
"As the cycles of years rolled on, and the age of stone gave place to that of bronze, the discs increased in size, and to make them less cumbersome they were ingeniously lightened by cutting out spaces between the holes and rims, which at length suggested the building up of the composite parts—namely, spokes, felloes, and nave. Then the inborn vanity of craft and workmanship, seeking to embellish, came in, and art unconsciously developed.

"Egyptians, Scythians, Persians—the artistic-loving, nimble Greeks—all alike, and in turn, took to the wheel. The Romans, chiefest of all artificers, by a rare combination of elegance and strength, brought it at length to a perfection of beauty.

"Why! not to be one of us and with us, is not to share in our common fame and glory—a great family with many branches of infinite variety and adaptation—everywhere found, either in one form or another, whether on land or on water—carrying or propelling, hoisting or lowering, driving or driven ; overshot, undershot, and sideshot—spur, bevelled, and mitred—wheels of balance and momentum ; to be found in every form and shape, and applied to every purpose, from the widely grotesque form which mounts and moves the Car of Juggernaut, to the slender, graceful wheels of the cycle, whose spokes for aerial lightness outvie the web of the giant South American tarantula.

"To a certain visible extent, we as a family control the affairs of life and death, as well as those of trade and commerce—the ushering of humanity both in and out of the world. Every event of life is more or less associated or influenced by us; we perform alike the highest and the meanest duties; in admirable co-operation, and in compass wide enough to overlook a city or to be included in a nutshell, we check and time the flight of the winged hours, to a fraction of a second.

"Your wheels of propulsion are but of the same stock as the humble carriers of the



One of "the revolutionists before whom ignorance and superstition fall back" (*page* 113).

costermonger's barrow, or the fly-wheel of the knife-grinder. All are the brain-children of Kluga the Cave-dweller. We, in our far-reaching family influence, are the true civilisers and peace-makers—the only true and honest communists of the age—the revolutionists before whom ignorance and superstition fall back. Blinded in your arrogance of place and pride, do you not see that we are common workers? and that not to be one of us, and with us, is not to share in the common fame and glory of the primeval Roller family?"

Whatever the driving wheels may have thought of this rejoinder, they said nothing that can be recorded here; and so far as their complaints, or those of others, were reasonable, they benefited by the renewed attention they received.

Upon one occasion the left-hand crank-pin, in a grandiose manner, and speaking, he said, for himself and mate, who was suffering from a rapidly developing flaw, delivered himself as follows:—

"You batch of grumblers, hear me! . . . Let it be known that we two are the true victims of force and circumstances. For millions of years we lay contented in nodule formation in a stratum at least twenty-five fathoms deep, close by the valley of the Wharfe. Unfortunately, however, for us, we had as near neighbours the two necessaries of regenerative life—namely, coal and limestone. In the Middle Ages the prying monks of Wharfedale caused us to be often raided to furnish materials for weapons of the chase and war. But these were only slight disturbances of our quiet. In the eighteenth century men with experience arrived, and, armed with modern tools, attacked us in the most systematic manner. With bores, pickaxes, mattocks, and even gunpowder, they reft and dislodged us from our ancient resting-place, and, without ceremony or excuse, hurried us to the surface and piled us in heaps in the blinding light of day.

"Then came a series of purgations. First, we were stripped bare as possible of our old habiliments by roasting-fires, and, in company with our neighbours, were carted and cast into the sulphurous depths of a gigantic furnace, to undergo an *auto-da-fé* of purification. To make the heat more intense, and in order to overcome our refractory nature, they employed an artificial wind, to which, in comparison, the mightiest efforts of Boreas were a zephyr. At last, after the lambent flame which lit up the country far and near had paled somewhat, we were so reduced, fluxed, and melted, and so subdued into one great mass, that when vent was given we flowed obediently in a white molten stream into various channels allotted to us in our newly acquired form.

"Compassionately they allowed us to cool in moulds of sand, and then insultingly called us 'pigs'; but where the likeness came in we could never understand. After a while strong men again attacked us with strange-shaped hammers, and we were broken to pieces in preparation for another and worse ordeal by fire. This time we were tossed, heaved, and twisted about in furnaces by the aid of long bars by men who seemed to sport at our misfortunes. But in this muddled and puddled state we became conscious of a rapidly growing change, the coming of a new life; for whereas before we had been crude, brittle, unreliable, and purposeless, the crystalline had changed for the fibrous, and we became tenacious.

"The more we were broken up, squeezed, and rolled, the stronger we became, until we realised homogeneity. Heaped, interfused, and welded into the final 'Use,' we found our identity lost, but only to take up another; for it was then, when lying in shapely bulk, that we were branded 'Low Moor'—another term for reliability, homogeneity, and slave-like endurance.

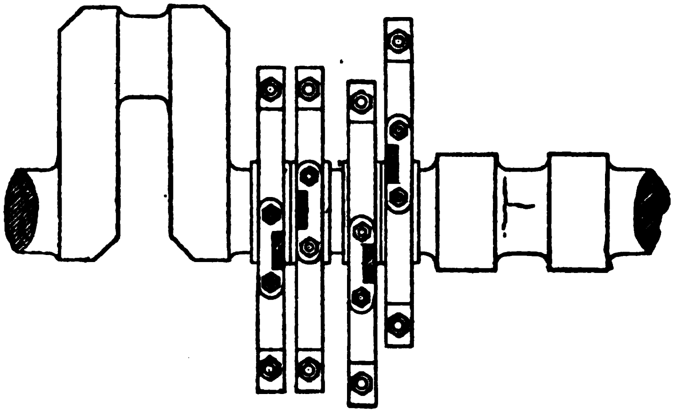
"Of the subsequent and more scientific torturing into shape by lathe and cutters, to which we were subjected, you know something; but we had now long understood that our many ordeals by fire and hammer were merely the preparation for greater and more persistent trials of endurance than even the hardest-worked member of our commonwealth will ever understand. For whatever the plaints may be of pistons, valves, connecting rods and wheels, and the whole of your beautiful motion, they are all concentred in us. We bear the whole burden.

"Through us, every effort at progression or retardation is made. Without us, the puffed-up and sullen old boiler is no better than an empty cauldron. Without us, the nimble pistons, after one move, would remain impotent and idle. Without us, the connecting rods, with all their glitter and pride, are no better than lazy and useless hangers-on. The wheels, without us, can only make a poor show of carrying power, without the ability to move, and your beautiful motion would be no better than a problem of useless and misapplied ingenuity. The valves, however well proportioned and full of theory, would be incapable of fulfilling their boasted functions.

"We are the transmitters and reciprocators of motion in the cycles of our movements. It is sufficient that we offer but one portion of each face to receive the pressure: that is enough. When we move, all other parts move in harmony. We are masterful, but obedient; tyrannical, yet oppressed; understood, yet misunderstood; toiling uncomplainingly through the pitchy darkness of midnight, until the awakening dawn, 'midst snow-wreaths or through sand-laden blasts. Over the rough and the smooth alike we toil on—never anxious ourselves, but a continuous source of anxiety to others. Too modest in our wants, we are satisfied with the merest dole of oil, stintingly given by a miserable half-clad piece of twisted wire and worsted, imprisoned in a narrow cell.

"Wise men have plotted out our movements and variations of speed, balanced and speeded us to their entire satisfaction, and put us under the government of laws: and yet we are a law to ourselves. Patient and long-enduring, we bear with equanimity the demands of others, whether desultory or continuous; never flinching from duty, although harassed at times with threefold knocks. We, the crank-pins, are the true, uncomplaining toilers."

Upon the voice of the last speaker ceasing, no other complaints were heard for some little time; but presently the silence was broken by a wheezy, asthmatical sort of a prelude, a strangulatory sound, as of a spasmodic effort preceding a bronchial fit, which for the time could not be located. Pretty soon, however,



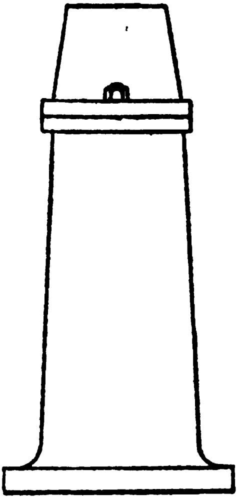
“We are the true, uncomplaining toilers” (*page* 118).

and much to my disgust and annoyance, I recognised in it the voice of the wrangling, puffed-up braggart of a blast-pipe, who had evidently caught the prevailing infection of discord.

When he had succeeded in making an intelligible utterance, he let out (as nearly as I can remember) as follows: "You are a bigoted, boasting lot, and consider yourselves, each set of you, as the principals, on whom all credit and responsibility depends. No doubt you look upon me—boxed-up here, and hid from the public gaze—as something too commonplace and dirty for association and companionship with such as you. In the fulness of your self-conceit, you allow room for no one else, and attach no importance to anything outside the circle of your own limited duties, always glorifying yourself at the expense of others.

"In your selfish ignorance, qualifying and considering me as a simple duct, intended only to convey and direct the waste steam into the chimney—not knowing that by its transit and exit the atmospheric balance is momentarily displaced, and that its restoration is the breathing actually necessary to your life and being—you look upon me simply as a foul-mouthed, ugly, and begrimed creature.

"But I am more than that, for although secluded and barred up I am the Fire-King, the Salamander, and here I hold my place, though scorched, blistered, yet enthroned in ashes, and wreathed round by a whirling sirocco of noxious sulphurous vapours and fire



"I am the Fire-King, the Salamander, . . . scorched, blistered, yet enthroned in ashes."

atoms. Without me, during the travail of work, the fires would sicken and die out; but under my pulsatory influence they re-kindle, and quicken into a state of glowing incandescence.

"I, yes I, am the great inducer of draught; I it is who coaxes the liquid, lambent flames into the hungry tubes; I bathe and lave the sides, ends, and roof of the fire-box, with ardent generating heat. Yes, I change the dull red of a draughtless fire into the overpowering heat of a reverbatory furnace, and transform the quiet, simmering water into a seething, effervescing, ebullient mass, alive with myriads of silver-clad spiral ascensionists (you only call them steam globules), that crowd and rush to the surface with their vaporous burdens.

"When understood and zoned aright, I become the quiet vassal as well as the monarch—the diffuser, circulator, and economical heat-producer—without protest and without vice. But when badly placed and disproportioned, I can make vehement and passionate protests; and more than that, I spitefully punish the tubes, arch the stubborn boiler, lock the frames, break the bolts, and make my protest against ignorance by acts of savage incendiarism. If constricted by ring or hook, in revengeful glee I retort by wasting coal, and illuminating the country with an extemporised display of fireworks. Then I am the Pyrotechnist. At times a beggar, craving the freedom of a quiet utterance and a proper status, ignobly capped by some, and be-petticoated by others, I am still the King, although in captivity—the Ruler, although in durance; not like you croaking, clap-trap satellites, merely revolving and moving in the open common order of your being. You mistake your vocation. I do not mistake mine: I am the *Deus ex machinâ.*"

After this utterance there followed a whimpering, exasperating cry in the rear, which I knew only too well, as I had heard it under nearly every conceivable condition of engine life for many years—an ambiguous cry, blended with a sound as of the jarring of partially applied brakes and the jangling of rods—a cry which might be interpreted either as one of remonstrance against unjustifiable distressful treatment, or as an unpleasant reminder of one whose services must not be ignored. It was the cry of the tender.

Years previously the relations between myself and the tender had been somewhat strained, owing to its whining pertinacity to be on terms of equality, to be treated and considered as a helpmeet and coadjutor, and not as a tender only. This I could never consent to, and I had hoped that the emphatic decision which I had not failed to announce to my companion had for ever settled the question, and indeed all other differences.

The spirit of dissent and opposition, however, had evidently brought about a revival of the old grunts and groans. "For fully twenty years," the tender was now heard to say, "I have been coupled on to Ajax, adding to his length and importance; ungrudgingly ministering to his whims, as well as supplying his inordinate appetite for coal and water; renewing his strength, imparting new energy, restraining his impetuosity when running into danger, and keeping him under judicious control;—yet withal treated as the commonest drudge, without reward, notice, or sympathy—regarded, not as a help, but as a necessary evil—oft-times reminded that I am so much dead weight, and a perpetual care and tax upon his energies. I have heard him repining at times that he was not self-contained as a tank-engine, yet forgetful of the fact that I carry eighteen hundred gallons of water, and three tons of coal, which could not with the greatest stretch of ingenuity be stowed around his person without dire inconvenience to himself, and stress on the rails.

" Perpetually treated as an object of distrust and suspicion, because I have only four wheels ; and at times insultingly reminded that some day I shall be on the ground, should an axle break ; he, unmindful of my long devotion, has given me only desultory and indifferent attentions, holding, apparently, that 'anything is good enough for the tender.'

" I carry the marks of his culpable neglect in the blistered condition of the paint on my tank-plates, caused by leaving the warmer on too long, until I called him to a sense of his duty by lifting the tank-lid with a bang.

"Why should I be forgotten? No sprightlier or more buxom tender than myself was ever built or run on four wheels. My frames, if not so shapely, are equally as strong as carrying girders—I make no pretensions beyond that. My wheels and axles are of wrought iron, and, if not so large as his six-footers, as he calls them, are never laggards, and run just as quickly. The tank sides are sound and well stayed, and before I was so cruelly blistered the rows of rivets were beautiful in their pitch and regularity. The coping-plates incline gracefully upwards and backwards, and altogether I am more of a finish to him than otherwise.

"My long-continued devotion to him, although unrequited, has saved him many a time. But he has never been the same to me since he was for a time coupled on to the tender of the Flora, whilst I was undergoing repairs."

It was now high time to interpose with managerial firmness, for this exposition could not fail to have a demoralising effect. I therefore turned the warmer full on, and all further complaints were rendered inaudible. Yes, engines, like human beings, have their trials and worries, and must perforce at times "put the screw on."

These harassing self-laudations and bickerings, had they continued, must have made my position, not only ludicrous, but insupportable. On a previous occasion, I remember, some similar utterances were brought to an end by the unexpected and prompt action of the combined oil trimmings, who quietly announced their intention, unless the squabble ceased, to suspend all further capillary operations—in other words, stop the supplies—by withdrawing from their several positions, and thus give the opportunity to the recalcitrant members of proving what could be done unaided.

It was also evident that the scurrilous and injudicious reference made by the left-hand crank pin (in some such terms as I have given above) had its effect on these simple and unostentatious workers, for the plug trimming of that bearing, with a tinge of sarcasm quite foreign to his nature, went on as follows :—

"Although we are neither the reciprocators nor prime-movers, neither drivers nor driven, under no strain or compulsion, yet unacknowledged, we have our place and our uses in the commonwealth. . . . . . . We claim to be simple, quiet workers, even in the most cramped and trying positions. Without either plaint or reward, we are content to take our humble but thankless part for the common good. . . . . . We make no pretensions to such fine things as evolution and development (although with justice we might call ourselves Hydrostatists), nor do we complain of hardships undergone ; we are simply the commonest contrivance imaginable, and our utility is due to our simplicity of form and material. . . . . . We make no claims to equality ; we serve one and all alike ; it matters not where or how we are placed ; whether boxed-up or screwed-down, whether tortuously twisted, bent, or cranked, it is all alike. Isolated or in conjunction, we are contented and constant workers. We ask no better terms than the most moderate elevation, and that the unctuous material be of the necessary fluidity. . . . . . . We claim no ability to lift beyond the eighth-of-a-foot. . . . . . Unpretentious, and so circumstanced as to work without noise or apparent motion, we silently conduct our labours, to abstract and deposit the liquid unguent so essential to your movements and success, quietly and deftly insinuating the necessary interposing film, and thus preventing the hostile grip of diverse and contending atoms.

" Alike indifferent to the centrifugal effect of the whirling rods and to the comparative quiet of the axle-boxes and slides, our sole desire is to prevent friction and heat, and to maintain harmony and smooth working.

" If you cannot ensure us the simple conditions we require, we will withdraw, and leave you all to shift for yourselves."

In a combination of parts like mine, with their necessary interdependence on each other, the difficulty is to assign or estimate the proper degree of importance to each. Although lack-ing autonomy, several of them, like many a good man, boastfully claim more than their right, and attach a fictitious importance to their duties; whilst others, with a modesty as estimable as it is rare, hold aloof in their proud self-respect. However, I must admit that, vexing as these annoyances may be, it is only when failure or breakage occurs that we realise the necessity and value of the several parts of one's own autonomy.

ENGINE-DRIVERS

THIS autobiography, incomplete as it must inevitably be, would be still further wanting were I to omit all mention of the drivers, whose doings have been bound up in my life's history.

Passive obedience, in spite of protests and disagreements of parts, has been the main principle of my organisation, and though often bemoaning the incompetency of men who have not understood their duty to me, or my duty to them, I have, as far as circumstances would allow, always submitted, even when my reputation was at stake; for the good name of engines, like those of men, often suffers unjustly in the hands of the thoughtless, the ignorant, or the indifferent.

Too often I have been under the charge of men who have never travelled or sought the *via media*—who were extremists in all they did—having only very imperfect notions of duty, leading to a superabundance of care in one direction, and to partial or complete neglect in another, and perhaps the most important; or in other instances resulting in attention to the important matters only, and the neglect of those minor ones which so largely contribute to a perfect success.

Such men I have known amongst drivers, who, forgetful of the sustaining and economic laws which govern themselves, have boasted that after once firing they have completed a whole journey without needing another shovelful. Choking-up or drowning-out were their ideas of successful driving, and when such practices were not at all times successful, their attitude might be summed up as "damning" the machinery and those who had made it. Forgetful that they themselves were wanting in method, order, and regularity, they yet expected the best results.

Some drivers I have known also, who were too idle to carry out the most ordinary precautions; others so irritable as to be a source of constant annoyance, dashing the levers about in a frenzy of passion, or in wanton revelry of the power placed under their control.

But why should I linger on such unpleasant recollections? I am now too old to feel resentment, and even were it not so, I know that unfortunately such must at times be the lot of every engine. When the true man comes, who studies you and your every want—who possesses the pride of place—who would not exchange his position with the proudest in the land—who feels and identifies himself almost as a part and parcel of yourself—who prides himself in your strength and glories in your speed—who knows your best points and will not unnecessarily misuse them—who is as chary of your honour and reputation as his own—who regards you as his own special perquisite, and is jealous and apprehensive of your falling into the hands of others—whose pride and solicitude are shown by regardful movements more eloquent than words—who with the choicest piece of waste obtainable affectionately touches or rubs you up here and there, and, as though he could not help it, polishes up what is already polished, so long as he can thus show his pride and interest;—then an engine may be trusted to do his best indeed, and make a grateful return for all this "love's labour." Such a driver as here described will often carry in his pocket, for your delectation, a few fancifully made trimmings or special corks, which he swears are his favours; and sometimes, with mistaken zeal, he will gather and garner, even by questionable means, and from all quarters, miscellaneous oils for your particular gratification and benefit. I have had several such drivers, but none who understood and cared for me better than Will Carter and Bob Steel.

The first, a born engine-man and mechanic, reared and taught in the colliery districts of the North—the training college of Nicholas Wood, John Gray, Hackworth, and a host of others—had had for his curriculum hard work and self-reliance, stimulated by love of all things mechanical. Although young, he was equally at home in manipulating the colliery winding-wimsey and the two side-valve levers and treadle of the gab-geared engines, and had done good work on one of Gray's horse-leg expansion-geared locomotives. Without prejudice, and inherently fond of a good engine wherever built, he, I am glad to say, was selected to be my first driver. Do not put it down to sentiment; but I cannot forget the almost boyish delight he exhibited, nor the pleasure he took in examining for the first time every point of interest in my construction.

No peculiarity of part, and no notable feature, escaped his eye. He was never tired of examining and trying lever, taps, and handles, noting their positions, and following their connections. All underwent a careful survey and trial. I felt satisfied that his size and build, when on the footplate, would accord well with his duties. He took his stand there with the weight and force of a man of anticipatory readiness. Grasping the regulator handle, and admiringly scanning the symmetry of boiler and dome, he seized the chain, unlatched and swung open the fire-door, and peered inquisitively into the recesses of the fire-box with the most profound interest.

The hearty grip that he gave me, when for the first time he grasped the reversing lever, and, stiff and unaccommodating as I was, put it through all the intermediate notches from backward to forward gear, trying each one separately, inspired me with confidence, and I felt that I had a knowing and firm character to deal with. Work with him was a pleasure, and not a duty. That trial-run which followed was an epoch. Every working part had been carefully, yea lavishly, oiled beforehand; glands had been re-adjusted, gibs and cotters examined and made secure, tools counted, spanners tested. At last I moved forwards and backwards, in response to the carefully opened regulator; and at length, when the gushing pet taps, along with the cheerful chirrup of the clacks, assured him that the pumps were all right, I knew that I was in for a smart run.

In less than a fortnight we were on the best of terms. Soon he knew to a nicety when and where I was at my best, and every day I grew more responsive and easier to his hand, and more satisfied with him and myself. I never had cause of complaint in the years we were together, for I knew that his affection was divided between his family and myself. Manly

—yet jealous of interference, as all good drivers should be—he would rather have worked an extra turn for nothing than allow others to handle me. He studied my peculiarities, and adapted his treatment to suit. The feed-valve handles were so marked that adjustment to varying loads ensured a constant feed. Almost intuitively he understood the most suitable positions for expansive working, and under his treatment the regulator had other functions than that of a steam-valve.

The brotherhood of "touch" existed between us, and I never pleased him so much as when I responded to his handling by simmering my approbation at the safety valves. But it was on shed-days that I understood his true value, and experienced the thorough washing-out, tube-sweeping, re-trimming, and the re-packing of glands which it was my good fortune to undergo. These duties at that time were performed by the driver and his mate; and had it been otherwise, Will Carter, I am sure, would not have allowed, or even trusted, others to undertake them.

Fortunate to be under the care of such a man—one who held to the axiom that "to do a thing satisfactorily you must do it yourself," and who avoided difficulties and breakdowns by thoughtful anticipatory preventive measures, and left nothing to chance—was there any wonder that I felt the difference when, as was too often the case during the changeful course of events, it was my lot to endure the opposite of such treatment?

I may have succeeded, although imperfectly, in giving the character of Carter; but how shall I manage with Steel, the happiest and strangest compound of human nature that ever occupied footplate in driver's form?

Although with him for years, I never knew his county; but, judging from his southern tongue, he was not of the North. He soon convinced me that he knew his work and took a pride in it. In spite of his mirthful and somewhat juvenile appearance, he was uncommonly shrewd, as well as strikingly original in speech and act, and full of resource, almost to inventiveness. Quaint and outspoken, without being foolish or whimsical, he was a rhymester, and a singer as well, although of two tunes only, which were the sure indication of good-humour, or occasionally of displeasure—for I never knew him to show anger. He openly affirmed that I was the best engine he had ever known, but qualified it by saying that, if allowed, he could build a better.

Bob was a quiet experimentalist in his way, and often tried my patience by not letting well alone. I have known him to have five or six of his notions at work on me at one time; but his good-humour and sunny disposition more than reconciled me. The only shadow in his path was old Nixon, the works foreman, who, in the spirit of his class, would insist that he knew the engine, and what was needful, better than Steel. Intuitively I could tell when they had met to disagree, by the bustling way in which Steel mounted the footplate, and would commence humming his favourite tune of "Scots wha ha'e"; but the bellicose fit never lasted long, and when the tune was changed for "Old dog Tray" I felt more contented, knowing that he was himself again.

Their greatest contentions were respecting the proper weight on my driving wheels, and the set and lap of valves. Nixon used to make occasional alterations, without letting the other know; and in order to detect any such aggressions Bob used to make wire gauges of the position of the axle-boxes and valve-spindles to his own liking; and should any serious discrepancy be found after repairs, he would insist that Ajax was Ajax no longer. I must say that he was generally in the right, although oblivious to conditions.

One of his choicest fads was a good model of my valves and ports, by which he would logically prove, to his own satisfaction, and to the bemuddling of others, that with the absence of internal lap I was not nearly as good as I should be, owing to the steam getting away too early; and much to my chagrin he at length persuaded our Engineer to fit me with valves with a quarter-of-an-inch internal lap, promising that he would then conclusively prove the advantage. The result was a severe blow to our joint prestige; for how we blundered through that miserable journey I could never tell, and my old friend left me that night for the first time very much disappointed and indeed miserable. Nevertheless, many of his schemes were really good, and his career as a driver justified the high opinion in which he was universally held.

He was full of specifics. As a consequence of his success and reputation as a good driver, he was considered a great authority, and was often consulted by his mates on matters pertaining to the management of engines. Wise and often mysterious in his replies, like all oracles, he frequently left his clients in doubt as to his true meaning. But this I have noticed as a peculiarity of men of far greater pretensions than Bob Steel. When wishful to be *very* impressive he rhymed, but without madness.

Ill-treatment and neglect since those happier times may have blurred and blunted my memory; yet I still retain in mind a few of his proverb-like answers, and I can well recollect how ill-suited were the mysterious air and knowing look then put on to his otherwise smiling and somewhat jocular-looking countenance.

I remember well that he presented the Chief

Engineer with twenty-eight "rules and regulations" in prose and verse, which he suggested should be observed by engine-men. The hints, though not the prose or the verse, were considered so valuable that Bob, much to his and my own astonishment, and to my regret as well, was made Inspector.

One of his favourite saws was:—"Treat your engine as you would yourself, with consideration, and it will have consideration for you." This one was always said very knowingly:—"A full glass is like a full purse, the better to draw upon." But it occasionally varied as follows:—"A full glass is better than an empty one—if only for steaming."

This was a great favourite, and was always accompanied by head punctuations:—

"Rather than blow off at the valves, blow into the tank,
Then among the coal dodgers you surely will rank."

This would be said very ambiguously:—

"If in economy you wish to lead,
Regulate for a constant feed."

Another ambiguous utterance was:—"A

badly managed feed requires a well-handled regulator." Very mysterious was :—" The chimney top is a bad blow-off cock."

A favourite remark put in bad form was as follows :—

" A little and often put on the fire,
Keeps up the steam and you out of the mire."

A piece of advice always spoken with much unction was :—

" When trimming, trim yourself,
Trim to suit your engine and not yourself."

Another piece of advice was :—" If you trust others to pack your stuffing boxes, see they are properly locked, or, what is better, lock them yourself."

Were it not that I am becoming somewhat impersonal, I could give many more examples of Steel's aphorisms—some on the use and abuse of the oil-feeder, for instance, or his observations on the quickest and best methods of uncoupling. I might relate, too, many of his strange ideas and dodges ; but I regretfully admit that I cannot reproduce his style, and so had better refrain. Those, however, who knew him will at least recognise something of it in what I have given, and will feel that an old engine has only done him justice by giving him a place in this autobiography.

Even now it pleases me to think that, dust-covered and rust-bound in motion, in pistons and valves, as I now am, I have in my time been the pride and admiration of such good men—men who did not in the height of self-conceit flatter themselves that the acceleration or slackening of speed, the making or mending of a fire, the opening and shutting of a throttle-valve, with the accepted style of gearing-up—that these things alone constituted a driver; but men who, as devoted attendants, faithfully and lovingly studied the application of those duties which best suit the principles and peculiarities of an engine's organisation. With them, the most equable temperature of fire-box and boiler meant all-round good results; but to accomplish this, as careful firing and as constant feeding as possible were necessary. By such drivers extreme measures were never resorted to, because they were not needed, and thus were avoided those sudden rises and falls of temperature which so undermine the constitution of the soundest locomotive.

EPILOGUE

HERE the old engine ceased speaking, and after waiting some little time I was about to close my note-book, thinking that the interview had finished, when I heard him muttering and soliloquising to himself in the half-inaudible manner peculiar to old people on the verge of senility. The rush and whistle of a passing express recalled him from his reveries, and, recognising my presence, he once more reverted, in the fashion of the old and pedagogic, to his youth and ancestry, in a manner which I have always found to be a sure sign of mental imbecility.

"Yes," he said, "at first, like all animated nature, we have had our stages of germ or embryo, unprogressive, awaiting the potential and life-giving forces of necessity and intelligence. Who knows but what our protoplasmic state originated with prehistoric man, who, although stone-blind to its future, showed by confronting the difficulties of life with weapons of silex, his ingenuity in providing for his simple wants? In this, mind, or adaptation, was in keeping with the object.

"Next in evidence of the extraordinary growth of ideas," he went on to say, "is the wonderful character of the mighty ruins in the East, the building of which could not be accomplished by other than mechanical means, actuated by steam. Their origin and history appear to be lost amidst the warring embarrassments and changes of the human race; and you will find (as I think I have already instanced) that the first record of the recovery is identified with the golden era of Grecian thought and progress.

"Whenever the opposing tides of men's passions have conflicted, our development has been retarded or lain dormant, but at no time dead; and as the centuries have rolled on, and the occipital development of man has progressed, the idea would again capture the man, or the man capture the idea.

"You will thus gather that I am somewhat of a disciple of Darwin, and the older I get the more confirmed I become in the doctrine of the survival of the fittest; for when first fashioned, I, sir, was the re-incarnation of lost ideas—the awakening of the dreams of Leonardi de Vinci—the resuscitation of the dead child of the Marquis of Worcester—the practical outcome of a regenerated Rocket and an improved Planet. O *mutabilis mundus*—to be in turn cast on one side to make way for the stronger and more modern robust, with which to meet the growing demands of an ever-dissatisfied community, who have no constant finished ideal, no definite state of perfection, only an apotheosis which even steam, however pressed and sublimated, can never fulfil! . . .

"It was a belief of the ancients that a dying man's utterances must needs be prophetic. The doomed old Ajax claims the gift of prophecy. No doubt the daring sons of the man-god will not be content until they have captured to the full the secrets of 'Electron,' the true Promethean fire. Already they are discontentedly discounting the value of steam as a motor. Already, by a touch on a button, they can accomplish in seconds a speed which the best and quickest of my race can only by much labour and vehemence do in hours. It has already become unfashionable to speak of 'units of heat,' 'pounds of pressure,' 'size of cylinders,' etc. They now delight in a strange jargon, in which such words as 'ampère,' 'volt,' 'ohm,' and 'kilowatt' predominate. They compile a lexicon of their own.

"They audaciously imprison and use forces which were formerly the proud prerogative of Jove himself. They bottle them up like the encaged genii, to let them loose in strange fashions to do their behests, to speak without voice. By means of innocent-looking diaphragms they can imprison the human voice, to be repeated in ages to come. They urge their merits and express their desires through the smallest wire. Without it, they will, by means of the intelligible vibrations of the subtle fluid, overcome the mountain bulwarks and cross the seas. Some, more daring than their fellows, can pass the lightning through their own bodies and yet live, and by a trivial alteration of procedure can cause instant death to others.

"Yet withal, when the summit of contrivance has been reached, and inventors shall be discontented still, though revelling in the repositories of nature's choicest secrets, they will have to admit that the stimulus which produced their proudest attainments must be accredited to the age of steam locomotion and its deathless afflatus. The knowledge that this consummation is due to locomotive enterprise is at all events a gratifying consolation to the old engine."

I thought that old Ajax acquired an exulting tone towards the last. In a few moments he once again gave place to reverie, and with crooning voice (and without apology to Homer) he finished with the following lines:—

"It will come soon—that day decreed by fates,
How my rods tremble as my voice relates!
The day when thou, O mighty steam, shall be
No longer used in factory, land, or sea.
Scrapped I shall be before that eventful day,
Or thrown in furnace' maw, or piled in heaps away:
Boiler and frames, axles and motion blended,
Tubes melted up, and all my glories ended."

Printed by Hazell, Watson, & Viney, Ld., London and Aylesbury.